HISTORICAL SCIENTIFIC DISPLAYS DURING THE GERMAN EMPIRE: THE ROLE OF SCIENCE, NATIONAL IDENTITY, AND BOURGEOIS CULTURE IN THE GROWTH OF THE HISTORY OF SCIENCE AS A DISCIPLINE

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ABSTRACT

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The dissertation locates the start of the institutionalization of the discipline of the history of science in Germany during the Empire. Primarily using examples of scientific historical exhibitions and displays, history of science scholarship at conferences, and memorials to scientists, I trace how Germany led other nations in the discipline's early, or proto-, institutionalization, according to five criteria for institutionalization I define at the outset. In addition, the dissertation explores the social and political circumstances during which these developments transpired. It emphasizes the centrality of exhibitions presenting the history of science to the wider German public as a unifying element to help build a new national German identity. It also argues that Germany's leading role in starting to form the discipline of the history of science can in part be explained by the strong historical consciousness of nineteenth century Germany, the strength of contemporary German science, and the desire of members of the bourgeoisie to make science history one of the cultural goods it provided the nation.

A few *permanent* exhibitions relating to the history of science, most notably those at Kassel and Dresden, had long existed in German lands. However, during the German Empire, these were augmented by a number of others. *Temporary* displays of the history of science were a relative novelty before the 1870s. After German participation at the International Exhibition of Scientific Apparatus in London in 1876, the first such international exhibition, Germans launched a succession of events displaying and exhibiting the history of science both

domestically and internationally that exceeded the range of the counterparts of any other nation before the end of the First World War. By itself, this was a notable phenomenon. When the other activities involving the history of science performed during the Empire are joined to its displays and exhibitions, Germany during the Empire stands out as having taken a unique role in the formation of the discipline of the history of science.

ACKNOWLEDGEMENTS

This dissertation work goes back at its origins to discussions with Professor John Waller on the 1876 London-based International Exhibition of Scientific Apparatus. He checked several documents for me at the Science Museum in London—an institution that arose after a long-delayed transformation of the International Exhibition into a permanent British museum of natural sciences—pertaining to the exhibition. This was the start of my interest in following up more about the exhibition, and from there, about German Empire historical scientific exhibitions. The ongoing research ultimately led to an unanticipated conclusion: the early institutionalization of the discipline of the history of science should be defined with more precision, moved a little further back chronologically, and located foremost within the German Empire.

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INTRODUCTION

This dissertation seeks to recover an undeservedly forgotten episode in the history of the history of science: the early German activity in history of science displays was part of a larger German contribution to setting the discipline of the history of science on its feet, and neither has received its due in the historiography. While I give a full treatment of German Empire history of science displays, it should be borne in mind that this treatment is meant to provide evidence to support the more general claim. Some of the historiography has intimated a certain early role for Germans in formation of the discipline of history of science; much prior work, though, has neglected to assign an early enough start to its institutionalization and has accordingly left Germans' role largely unrecorded, while other sources discuss the advent of the history of science at a time before the late nineteenth century, without claiming any institutionalization of it. The dissertation makes as its principal argument that, on the basis of several criteria of the history of science's (proto-) institutionalization that I will elaborate below, the proposed start to the continuous interest in it extending up through the present should be pushed back earlier in time than most commentators have done, and Germans given due credit for their indispensible role in this process.

What I am presenting will be functionally divided into two: a descriptive treatment of the phenomenon itself of German displays, and an exploration of those factors in nineteenth century German intellectual and social life that made German lands the exemplary site for the launching of initiatives including displays central to the discipline building of the history of science.

DISCIPLINE FORMATION

I will show that, in a rich variety of ways, nineteenth-century Germans expressed an enthusiasm for the history of a set of ideas and practices that were coming to be strongly associated with the rise of Germany as an integrated and powerful state. This, along with other factors, led them to becoming pioneers in setting in place the initial elements of the formation of a history of science discipline.

To allow a proper consideration of my thesis above, it is imperative to have a specific set of criteria for what I am calling the (proto-)institutionalization represented by the activity in the history of science in Germany. The first element is that scholarly activity (monographs, congress paper presentations, articles and editing projects) should be essentially sustained until the later full flowering of the discipline, as defined below. Second, the range of the spectrum and the level of activity in the history of science should be of a marked nature. Third, an established network of people interested in a common enterprise should be underway. Fourth, there should be one or more periodical publications devoted to the field. And fifth, ongoing organizational frameworks of some kind must be present. In the course of the remaining chapters I will provide evidence for all of these elements in the case of Imperial Germany. Of the five criteria, the displays of the history of science satisfied particularly the second and third.

It may be noted that in the sources whose take on the formation of the history of science discipline I will detail, none of them is specific about the criteria used in their assessment. Therefore, it is possible that they were operating under the assumption that no institutionalization can be claimed until all the building blocks have been put in place (though I would contest this understanding along the lines given below.) Three additional elements *not* present prior to the First World War in Germany or in other nations were (with a couple of exceptions)

professorships of the history of science or technology, degree programs, and a dialogue back and forth among actors sharing a sense of a *professional* undertaking. These would probably be required for what is generally understood as full flowering of a discipline. Therefore, I have chosen to refer at some points to what transpired in Germany up to 1918 as the early institutionalization, or (proto-) institutionalization, of the history of science, denoting that a number, but not all, of the specific building blocks for the institutionalization of the discipline were put in place in Germany during the Empire. Nonetheless, having achieved five of the designated eight steps in its institutionalization, I maintain that Germany can still be claimed to have gotten its disciplinary formation underway. The lacunae in much of the historiography on the history of science then, are the specific German Empire achievements, largely overlooked or discounted as to their significance, along with a convincing presentation of the criteria for institutionalization.

A display mounted in Cologne in 1894 gives the flavor for what was transpiring in the realm of exhibition culture within the early German activities in the history of science. This display occurred at about the mid-point in the sequence of the displays to be covered below. It brought before its visitors a select few of Gerardus Mercator's cartographic productions from the sixteenth century. Mercator was (and is) renowned for introducing what became known as the Mercator projection into cartography, a means of reducing the distortion in two-dimensional representations of geographical surfaces. In his own day, he also achieved fame for the production of early, majestic terrestrial and celestial globes and scientific instruments including astrolabes. Along with Mercator's published maps, the display showed reproductions of Mercator maps, printed slightly later, from plates of Mercator's purchased by Willem Blaeu, also a famous cartographer. It also included some material produced by Mercator's son. It presented

in addition some few printed works devoted to Mercator's achievements. The display was mounted at a library, and the general public thus had access to it.

The catalogue of the exhibition included the claim that Mercator was a fellow German countryman. This assertion was hardly an uncontested one. Mercator was born to German-speaking parents who happened to have been on vacation in a Flemish-language territory at the time of his birth. Although Mercator did also spend a long stretch of time in adulthood as a professor in the German university of Duisburg, he had been educated in Flemish lands and also learned his craft of cartography there, all these factors giving rise to later claims that he was Flemish. It is thus notable that the display catalogue asserted without any reservations that this famous early scientist was German. One of the arguments of this dissertation is that the history of science played a role in consolidating German identity during the period of the Empire: the high standing of science generally during the nineteenth century, along with Mercator's undoubted historical importance, made it desirable to contest for Germany his nationality.

The very fact that a display of such limited dimension was presented implies that by 1894, Germans had increasingly been alerted to the interest of the history of science. Displays featuring the history of science were a relatively new phenomenon in German lands (or elsewhere), but by 1894 a number of significant such displays mounted by German organizers had made an impression on the public. Previous displays had precipitated a sufficient interest, and had strongly enough linked early scientific achievement to the significance of the Germans as a people, to make even a modest presentation with a focus on the work in cartography of a single, reputedly German, scientist, albeit one of importance, worthwhile.

The interest of German Empire displays of the history of science is amplified through the fact that in other nations, displays with historical exhibits were not as numerous, nor did they

mount a comparable *range* of displays. The German events had more significant variety of the scientific fields and depth of time exemplified: some scarcely reached back to the beginning of the nineteenth century, while others exhibited scientific instruments extending back to the fifteenth century Middle Ages and manuscripts reaching back to the ninth century, or even with medical implements from classical times. Some German displays featured astronomy, others chemistry, and still others geography or physics, as well as those showing appurtenances and graphical representations relating to medicine. German displays also ranged in scope from the small 1894 Cologne Mercator display to the Central Pharmacy Museum established in 1883 within the German National Museum in Nuremberg, and to German participation in historical displays overseas, including the first international exhibition of science in London in 1876, the international electricity exhibition Paris in 1881, and the Chicago World's Fair in 1893, and to the opening of the displays on the history of science in the soon-to-be-premier Deutsches Museum in 1906, with thousands of exhibits. Finally, the intended audiences for certain displays were specialist practitioners of sciences, in others, the general educated public, and in a couple, virtually anyone. Displays are an important illustration of the increasing network of people in the German Empire with an interest in the history of science and their frequency during that period is one indicator of the level of activity that this interest gave rise to. Collectively, German displays will serve as my primary illustration suggesting the German jump on other nations in institutionalizing the practice and the field of the history of science.

However, in the dissertation I also treat other aspects of the developments during the Empire in the formation of the history of science discipline. Overall, the German embrace of the history of science, from sometime after the mid-nineteenth century, and particularly during the period of the Empire, was lively and far-ranging, and I will provide details in Chapter 1. As just

mentioned with regard to displays, some aspects of the phenomena concerned primarily specialists—the practitioners of science themselves. Such was the discussion, for example, of the history of science topics presented at the formal meetings of the community known as German Scientists and Physicians, scattered at their annual meetings throughout most of the nineteenth century. Other aspects of the German involvement with the history of science brought an awareness of it, and the resources for gaining a greater appreciation for it, to the non-specialist public: statues erected to scientists performed the former, while the publishing of correspondence between famed scientists was an example of the latter.

Germans had done much towards forming a full-fledged discipline of the history of science, albeit to some extent one contained by national borders, by the fall of the Empire in 1918. Though it had competitor nations, the list of its areas of activity in the history of science in the nearly five decades after its unification in 1871 goes beyond certifying that German Empire participants were *among* those of various nations to erect a foundation for the history of science: Germany simply *led the way*. Other nations' scientific cohorts were not quite as fast as Germany's to take up the early steps in the institutionalization of the history of science, though some of these other nations were not far behind with respect to certain *individual* elements of institutionalization. In the case of history of science displays, the German Empire's chief rivals Britain and even France were not as active as Germany in the period of its Empire, although they already had important permanent scientific exhibitions, respectively, at the science section of the South Kensington Museum (London) and the Paris *Conservatoire des arts et métiers*.

This dissertation's exploration of the multiple facets of both sporadic, and increasingly regular, German attention to the history of science, particularly during the period of the Empire, should be of interest to those who seek an understanding of the early phases of the

institutionalization of the discipline of the history of science. Germans had proven themselves to be the originators of a number of disciplines over the centuries, and their preliminary moves in this direction for the history of science became evident soon after the founding of the German Empire.

CAUSAL FACTORS

To make sense of the developments sketched out above, we need to inquire what possible causal factors impinging on the history of science discipline formation in general, and the mounting of historical scientific displays in particular, were operating in Germany during the period of the Empire. Before this period, there seem to have been few or no temporary historical scientific displays in which German states participated, a statement that is true of other states as well. The abruptness of these developments, as well as those in the improved documentation of the two venerable German historical scientific collections in Dresden and Kassel at exactly the same period, suggest that some general but also some more immediate precipitants were at work, involving social, political and economic conditions.[1] I will be maintaining that four factors were largely responsible for the German lead in promoting the history of science: the high level of contemporary German science; the avidity with which Germans embraced history in its various manifestations; the potential through telling the story of science, with an emphasis on past German science, for the legitimization of a new German nation; and the focus of the bourgeoisie

[1] Gerald Heres, "Die Dresdner Museen," in *Geschichte Der Stadt Dresden: Von Der Reichsgründung Bis Zur Gegenwart*, ed. Reinhard Blaschke, et al. (Stuttgart: Theiss, 2005), 153. Adolph Drechsler, *Katalog Der Sammlung Des Königlichen Mathematisch-Physikalischen Salons Zu Dresden* (Dresden, 1874). Ernst Gerland and August Cöster, "Die Sammlung Des Astronomischen, Geodätischen Und Physikalischen Apparaten Aus Dem 16., 17, Und 18. Jahrhundert Des Königlichen Museums in Kassel Und Beschreibung Derselben, Namentlich Derer, Welche Auf Der Internationalen Ausstellung Wissenschaftlicher Instrumente Ausgestellt Sind," *Repertorium für physikalische Technik, für mathematische und astronomische Instrumentenkunde* 12 (1876).

on underlining their present role in advancing German science and their role in enriching German cultural life.

CONTEMPORARY SCIENTIFIC ACHIEVEMENT

Germans were excited for the very sense of progress and change that went along with intense scientific activity. So much was developing in German science, along so many lines of investigation, in so many existing fields and nascent specializations, that science and its new findings were heavy contenders for the public's attention. Germans also felt, during the Empire, that their imposing science was as good as any other expression of their talent and worth as a people. They were primed to be patriotically moved by the science done in German lands in the past as well as contemporaneously.

The impressive strides that were made in the discipline formation of the history of science during the German Empire can partially be credited to the powerful contemporary German scientific ethos. From relatively early in the nineteenth century, the impact and reach of German science were on the rise, having for a century and more previously been, in sum, less impressive compared to that of France and Britain. By sometime about the middle of the century, Germany assumed a leading position in a number of scientific fields, and by the end of the century German leadership in additional fields had been attained.[2] That is, in the course of the nineteenth century, science in German lands (excluding in the main the German-speaking

[2] Jeffrey Allan Johnson, *The Kaiser's Chemists: Science and Modernization in Imperial Germany* (Chapel Hill: University of North Carolina Press, 1990), 201. Charles McClelland, ""Young Germans, Not Young Greeks and Romans": Art, Culture and Educational Reform in Wilhelmine Germany," in *Imagining Modern German Culture, 1889-1910*, ed. Françoise Forster-Hahn (Washington: National Gallery of Art, 1996), 38. Angela Schwarz, *Der Schlüssel Zur Modernen Welt : Wissenschaftspopularisierung in Grossbritannien Und Deutschland Im Übergang Zur Moderne (Ca. 1870-1914)* (Stuttgart: F. Steiner, 1999), 18, 194. See page 18 for reference to the reputation of nineteenth century "Germany [Schwarz's term is 'Deutschland'--here used to refer to the ensemble of the various German states]...as a land of science". William Coleman, *French Views of German Science* (New York: Arno Press, 1981), ii [no actual pagination].

Hapsburg region) gained ground rapidly, and arguably, they eventually dislodged France as the world's premier scientific center and then held this position for the decades from sometime after mid-century until the destruction of the First World War.

ATTENTION TO HISTORY

The sense for history that infused the nineteenth century German culture overall fostered the surge of attention to the history of science in the final third of the century. There was a strong belief throughout the culture that to approach topics and issues from a historical point of view yielded informative and credible findings. German nineteenth century historical studies, famed as they were, supported indirectly if not directly an increase of attention to the history of *science* in Germany. German fascination with history, combined with a wave of nineteenth century scientific accomplishment, became applied late in the century to the history of science.

As part of an intellectual climate, the appearance of historical scientific displays, just as of a burst of scholarship in history of science, signified a widened receptivity to, and sense of the importance of, the German scientific *tradition* in this period. Skill in building scientific instruments and in mapmaking and in production of early pharmaceutical texts, along with solid historical scholarship, had the appearance of being particularly German strengths. The nation, culture and language could all be celebrated through attention to the history of science.

NEED FOR NATIONAL INTEGRATION

Given the twin interests of Germans in science and history in the late nineteenth century, the onset of the preeminent German activity in the history of science at that juncture may seem inevitable. This dissertation posits that these factors were necessary but not sufficient. In

Germany during the Empire more than elsewhere, along with a general enthusiasm for science and the widespread influence of historical thinking, there were added crucial factors favoring its citizens' investigation of science's history. Through further elaboration of the German conditions during the period of the Empire, I aim to help substantiate the claim that the Germans were especially active in fostering the history of science partly in order to contribute powerful staves to the bulwark of the new national identity. The common roots so important to building up this identity included the strong past scientific achievements in German lands. Citizens of the German Empire saw their national fate as in some sense tied up with the deep past. Accordingly, the German catalogue for the 1893 Chicago World's Fair strutted that "[t]he German Empire looks back upon a full millennium of political, intellectual and industrial development."[3]

While these lands had never been politically united as a single state, the German Empire's publicists now sought to inscribe a common history, also known as a master narrative, for all those incorporated into the state. In a 2015 article summarizing her dissertation research, Floortje van Alphen along with her dissertation advisor theorized that "[m]aster narratives present the historical continuity of the nation. The identity of nation and nationals, fundamental for establishing the master narrative's protagonist, implies that in national terms past and present are the same."[4] Applying their description to the German lands, the character of the German individual as innately scientific became a part of the national master narrative, substantiated by both the scientific preeminence of German lands in the fifteenth and sixteenth centuries and by a more recent nineteenth century increasingly impressive German scientific output.

[3] Otto Witt, "Einleitung," in *Columbische Weltausstellung in Chicago: Amtlicher Katalog Der Ausstellung Des Deutschen Reiches*, ed. Otto Witt (Berlin: Reichsdruckerei, 1893), i [no actual pagination].
[4] Floortje van Alphen and Mario Carretero, "The Construction of the Relation between National Past and Present in the Appropriation of Historical Master Narratives," *Integrative Psychological and Behavioral Science* 49 (2015): 516.

After unification in 1871, science continued to count as a core element in what made the German national identity, while German science's history starting centuries earlier could serve as a high-profile invented national *tradition* (invented in that without a single German nation before 1871, an actual tradition for the nation could not have begun before that date) to contribute a legitimizing gloss to the unity of the new German nation.[5]

Some proponents of the new state feared that various subordinate identifications—religious, regional, class, ethnic, kin, profession, party, and state/dynastic—might persist among the citizenry of the new German nation/Empire. There had been an earlier conviction that it was indeed its regional particularities and characteristics that were valuable to the German culture.[6] Political and social cohesiveness required consolidation during the German Empire.[7] Patriots and officials now hoped to instill among Germans the conviction that their *national* affiliation was the most important one for them. Along with the other forms of dissemination of the history of science, the historical scientific displays organized by Germans held at home and abroad helped implant this conviction.

Some displays abroad in which Germans participated also implanted on the international stage the idea that Germany's current proud present was matched by a proud past. A number of the displays at which German organizers exhibited historical scientific objects were held outside of Germany, or were organized at locations in Germany hosting an international audience. Precisely because of the high stature enjoyed internationally by contemporary science during the decades of the German Empire, such displays inescapably stirred a recognition among *non-*

[5] This general concept is drawn from E. J. Hobsbawm and T. O. Ranger, *The Invention of Tradition* (New York: Cambridge University Press, 1983).
[6] Dieter Langewiesche, "Kulturelle Nationsbildung Im Deutschland Des 19. Jahrhunderts," in *Nation Und Gesellschaft in Deutschland*, ed. Manfred Hettling and Paul Nolte (Munich: C. H. Beck, 1996), 59, 49.
[7] Lawrence Goldman, "Victorian Social Science: From Singular to Plural," in *The Organisation of Knowledge in Victorian Britain*, ed. Martin J. Daunton (Oxford: Oxford University Press, 2005), 96.

German viewers of the German scientific tradition and indeed of the formidable power of the German culture and intellectual achievements past and present. For German patriots, this was a desirable goal in addition to stimulating a national feeling among citizens at home.

THE CULTURAL PRE-EMINENCE OF THE GERMAN BOURGEOISIE

The particular timing of the developments in German history of science requires the additional explanatory factor of a specifically denoted role for the bourgeoisie in cultural affairs that became increasingly vital in late nineteenth century Germany. This dissertation will also then be suggestive for those researching the bourgeoisie and the ongoing impact of Enlightenment ideas.

The non-noble elite were themselves both among the founders of, and ongoing participants in, the German national project taking shape during the nineteenth century.[8] Once the Empire was founded, though, the burgeoning bourgeoisie found itself sequestered away from political agency. Its response was to drive ahead in the cultural realm. And within this realm, a range of activities largely undertaken by members of the bourgeoisie treated the history of science: societies and publications, scholarship and scholarly congresses, celebratory talks, university lectures, popularization of science in public talks and publications, and the central preoccupation of this dissertation, exhibitions. Constellation of new disciplines (one might mention physiology, embryology, and cytology among the natural sciences, and sociology among the social sciences), including history of science in all its forms, was an aspect of this cultural push. With the great majority of Germans active in sciences in the nineteenth century being of bourgeois origins or, in exceptional cases, of a lower station who had elevated themselves into the bourgeoisie, the latter's stress on the long-standing German achievement in

[8] James J. Sheehan, *German History, 1770-1866* (New York: Oxford University Press, 1989), 143.

science could cast an aura of inevitability on the importance of contemporary German science, and the bourgeoisie's contribution to it, and thus overall to the nation.[9] The rise of the middle classes in nineteenth century Germany was important in the genesis of historical scientific displays, as it was in the nation's solid contribution as a whole to the formation of the discipline. In addition to the national work done by German displays, there was some class work being done as well.

It was in fact mostly bourgeois Germans during the Empire who fostered the development in its earliest stages of the newly emerging discipline of the history of science. This activity was consistent with the achievement of their class in directing most aspects of life in the social order of the nineteenth century, including its festivals and exhibitions. As an additional example, the expanding bourgeoisie were connected to the founding of many of German lands' cultural-historical museums of the mid-nineteenth century.[10] Until the field of the history of science had matured more fully, those individuals likely to do scholarship in it were almost exclusively scientific practitioners themselves, drawn as noted preponderantly from the bourgeoisie. At this early stage in Germany, with perhaps at most a handful of exceptions, the people involved in doing one or another aspect of the developing of a history of science discipline, including scholarly research, would not have termed themselves science historians as

[9] See Myles W. Jackson, *Harmonious Triads: Physicists, Musicians and Instrument Makers in Nineteenth-Century Germany* (Cambridge, MA: MIT Press, 2006), 46 in which Jackson writes, "Clearly the practice of [German] science in the late eighteenth century had become increasingly identified with the bourgeoisie, and the numbers of participants had risen tremendously".

[10] Walter Hochreiter, *Vom Musentempel Zum Lernort: Zur Sozialgeschichte Deutscher Museen 1800-1914* (Darmstadt: Wissenschaftliche Buchgesellschaft, 1994), 111; Kurt Böhner, "Altertumssammlungen Des 18. Und 19. Jahrhundert Im Rheinland," in *Das Kunst- Und Kulturgeschichtliche Museum Im 19. Jahrhundert: Symposion; Nürnberg, (9.-11. April 1975)*, ed. Bernward Deneke and Rainer Kahsnitz (Munich: Prestel, 1977), 74; Gerd Spies, "Die Kunst- Und Kulturgeschichtlichen Lokal- Und Regionalmuseen: Zeiten, Auslosenden Faktoren, Initiatoren Der Gründungen," in *Das Kunst- Und Kulturgeschichtliche Museum Im 19. Jahrhundert: Symposion; Nürnberg (9.-11. April 1975)*, ed. Bernward Deneke and Rainer Kahsnitz (Munich: Prestel, 1977), 80.

their primary self-identification, for their activities at this early stage were an avocation for those who were scientific practitioners by vocation.

Like the several generations of German academic historians before them, the Empire historians would scarcely recognize the natural sciences in their own work: one recent account concludes that for the period in question, "[t]here are almost no traces of history of science in the journals and textbooks of German general historians..." They further took little notice of what their counterpart scientist-historians were doing, but nevertheless the latter's scholarly activity was as characteristic of the era's largely bourgeois-driven German society as that of the former.[11] And those Germans taking roles in the organization of historical scientific displays were in large measure members of the bourgeoisie.

THE MATERIAL ASPECTS OF INSTITUTIONALIZATION

Contemporary studies in anthropology and sociology, as well as history of art, sometimes take a view on display objects as having virtual lives, with relationships to their collectors and curators. Sam Alberti, in his book *Nature and culture: Objects, disciplines and the Manchester Museum*, points to such studies as treating the "metaphorical 'life" or 'career'" of material culture. Certainly, the objects brought together in historical scientific displays had in particular instances special significance for both collectors and those who oversaw their care. This would apply, in a general sense, to the origins of these human products or artifacts: the meaning attached to Germanic products (and potentially to antique Roman products as associated with early Germanic history) was different from those hailing from other territories and states. The

[11] Alexander Demandt, "Natur- Und Geschichtswissenschaft Im 19. Jahrhundert," *Historische Zeitschrift* 237, no. 1 (1983): 40. Christoph Meinel, "German History of Science Journals," in *Journals and History of Science*, ed. Marco Beretta, Claudio Pogliano, and Pietro Redondi (Florence: L.S. Olschki, 1998), 80. Dietrich von Engelhardt, *Historisches Bewusstsein in Der Naturwissenwschaft: Von Der Aufklärung Bis Zum Positivismus* (Munich: Karl Alber, 1979), 220.

meaning given to historical scientific artifacts originating with nineteenth century Germans' biggest national competitors France and Britain might well also have been somewhat different to that given to artifacts from less "threatening" foreign sources. Alberti mentions as part of the relationship of artifacts to collectors the formers' provenances—these might be fascinating in some cases, while not in others, to those who handled and displayed them. In the case of the Deutsches Museum, or the Treptower Sternwarte Museum, the museum directors themselves directly hunted down desired objects.

Oskar von Miller at the Deutsches Museum was known for his zealous pursuit of authentic specimens, travelling to German sites to uncover or obtain a desired object, as he did for a theodolite of Georg von Reichenbach that had been converted by Reichenbach's associate Joseph von Fraunhofer into a spectrometer. Simon Archenhold at the Treptower Sternwarte went Miller one better, travelling to Denmark to do archaeology at the site of the sixteenth century astronomer Tycho Brahe's Hven observatory (covered below), and bringing back to his museum a scientific artifact recovered by him there. The objects personally pursued and obtained by the German organizers of permanent exhibitions, not to mention those which had been saved by their efforts from the danger of being irretrievably lost, were in a particular relationship to the organizers compared to the relationship borne by objects which came unbidden as donations to the exhibitions.

(At least most of) the German Empire display organizers, when they put their display items into lines of development, or showed them in a rational grouping, were *arranging* them, rather than simply arraying them, as had once been the case, in exaggerated form, in the European cabinets of curiosity. As Lorraine Daston and Katharine Park express it, in those earlier forms of display, "[d]istraction as well as disorientation amplified the onlooker's wonder.

Not only did individual objects subvert commonplaces or shatter categories; from every nook and cranny uncountable rarities clamored simultaneously for attention."[12] In a somewhat less emphatic form, what Sam Alberti said of the curators of the late nineteenth century anatomical/pathological collections in Britain, who "sought to replace the perceptual promiscuity of the cabinet of curiosities with a regulated gaze, presenting the museum as a site for remote, reasoned observation…[Visitors] were subject to a strictly scopic regime…" was also true of (at least most of) the German Empire display organizers.[13] The arranged state of the objects in their displays brought the objects into a definite relationship to one another lacking in the more random environment of the cabinet of curiosities.

Among the display sites under consideration, the Deutsches Museum entertained a somewhat unusual stance with its inclusion of models of apparatus when original exemplars could not be obtained. To fill in a sequence of instrumental development, the museum administration went so far as to set out on its display shelves, in the place of an important piece of original apparatus, a notification that the piece was being sought, in order to stimulate either a gift of the desired object itself or donations for obtaining it. The museum also, when an original could not be obtained, built replicas in its own workshop or sometimes commissioned them, particularly for the cases when instruments with which major discoveries had been made were not available for acquisition. In the astronomy division alone, by 1922, nine replicas took positions among the display items (six already before the end of the Empire).[14] Thus, although Miller was diligent and fastidious in seeking authentic instruments, and rejected chimeras (for

[12] Lorraine Daston and Katharine Park, *Wonders and the Order of Nature, 1150-1750* (New York: Zone Books, 1998), 273.
[13] Samuel J. M. M. Alberti, *Morbid Curiosities: Medical Museums in Nineteenth-Century Britain* (New York: Oxford University Press, 2011), 194.
[14] Franz Fuchs, "Der Aufbau Der Astronomie Im Deutschen Museum 1905-1925," *Deutsches Museum. Abhandlungen und Berichte* 23, no. 1 (1955): 27-31, 48-50.

example of telescopes with substituted lenses) whenever possible, the museum's leadership was idiosyncratic in regard to preserving an inviolable authenticity of the objects it put on display. And the relationship that the museum's original exemplars bore to the simulated or reduced-size knock-offs that accompanied them on display was a less purist one than that which obtained, for example, at the Hamburg Museum for Arts and Trades. There, the scientific objects were genuine, each with its own aura of brilliance, but not illustrative of any lines of development. At the Deutsches Museum, and at the Liebig Museum as well, and also at the German Geographers Society meetings' historical map displays, the commitment to authenticity coexisted with pragmatic display considerations, resulting in a medley of artifacts that sat together somewhat differently than the objects at the other displays where there were no replicas or models.

On the other hand, at some displays, the categories of the display objects seemed random, and in this regard each category's relationship to the others was strained. For example, at the Kaiserin-Friedrich Haus exhibit, alongside the monasterial illustrated works were coins, portraits, and satirical illustrations of physicians and dentists. Objects so disparate did all fall loosely into the exhibition's theme of the graphic arts relating to medicine, but their relationship to one another were clearly different from the relationships between objects in a more focused display. At historical displays at the meetings of the German Geographers Society, maps joined navigational instruments and globes, while at the Treptower Sternwarte museum telescopes were accompanied by minatory old posters declaring upcoming eclipses. Such classes of diverse objects also related differently to each other than did the artifacts at the Hamburg Museum. Finally, the presence of non-scientific artifacts—amulets, magical rings, and the like—configured a relationship (discussed below) among classes of display objects at a number of

Empire exhibitions that was not consistent with the later majority view within the history of science community of the scientific pedigree that artifacts within its sphere must carry.

The period of the German Empire, from 1871 to 1918, seems relatively short to trace a trajectory of changing relationships of museum display items to collectors even for the case of the science division of Germanisches Nationalmuseum, which was founded early in the Empire. But it is possible to query the relationship of the division's early artifacts (reported on by curator Siegmund Günther in 1878) to those of objects added somewhat later (as reported on by Gustav von Bezold in 1907). There is no indication that the arrangement, or even the labeling, of the objects first introduced was significantly different in 1907 compared to 1878. The ordering was informed by a museum policy to illustrate lines of development already from Günther's time. But a number of objects at the opening of the division were culled from other divisions at the Germanisches Nationalmuseum. This put them on a somewhat different footing, from the vantage point of the museum staff, from objects subsequently donated or purchased.

Further, Günther at least *proposed* a card catalogue for all the artifacts he administered. Perhaps this was accomplished by him, whereas later, as conceded by von Essenwein, director of the museum, an expert resource person on scientific artifacts was lacking at the museum, so perhaps the card catalogue was not extended to artifacts acquired in the interim—in Alberti's argument, this would also have changed the relationship of the initial objects in the division to those added later.[15] Günther referred to having sought permission at least several times from von Essenwein to unload artifacts Günther considered "worthless". This would be a kind of "survival of the fittest" regarding a curator's selection criteria—putting display items still retained on a different footing with the museum staff, and with each other, after the eliminations.

[15] Anonymous, *Anzeiger des germanischen Nationalmuseums* 1, no. 6 & 7 (1884): 80-82.

It is striking that the 1907 account of Gustav von Bezold, who as the then director of the entire museum was trained as an architecture historian, of its scientific division nevertheless provides a more complete explanatory text on the functions of and operations involved in scientifically employing the division's artifacts than did Günther in 1878, or later in a subsequent account of the division's mathematical instruments that Günther wrote in 1894. Perhaps having a curator who had to train himself in understanding of scientific instruments impacted the "career" of these instruments as compared to the time when they were under Günther's care.

Finally, the mere long extent of the age of certain display objects lent them a different relationship to other objects in the displays and their caretakers than that enjoyed by less-aged objects. The status of "aged" confers on an artifact a different quality than that of merely "historical". Display items sometimes were simply on the basis of their being aged held to be relics rather than simply artifacts, if their age was profound enough—all the more so if they were in good repair.

Turning to the ideological meaning of the historical display objects assembled, I bridge to what has just been discussed by contending that, for the purposes of bulking up national heritage, aged objects were particularly valuable (and prized) as long as they were of reasonable quality. Their role in cementing claims of long-standing Germanic civilization made them so. Aged objects were not the only example of those objects considered relics. While some scientific artifacts were primarily representative of a type of instrument that fit into a line of development of instruments for a given purpose, and certain maps could stand in generally for a stage in the development of some aspect of map-making, artifacts associated with a scientist of renown generally also carried the nimbus of holy relics—all the more so if they had been used in making an experimental breakthrough or an observational discovery. Georg von Reichenbach's 8,075

kilogram salt mine brine pumping apparatus of 1817 (named the *Pfisterleiten*) was iconic for German technology and received a place of honor at the Deutsches Museum, underlined by the fact that Reichenbach himself was memorialized by a bust in the museum's Hall of Honor. But an apparatus used in making a discovery of even a contemporary scientist, if his discovery was considered epochal, might bear the quality of a cultural relic-in-the-making, a shrine for those allured by science, and all the more so in Germany by an apparatus accorded the status of "world's first". Empire Germans were elevated by the respect they were earning even in antagonistic nations for the achievements of their contemporary science. This could have hardly been better illustrated than by the apparatus Heinrich Hertz used to first detect electromagnetic waves (donated to the Deutsches Museum in 1913), or that with which Wilhelm Röntgen first demonstrated X-rays (donated to the same in 1906).

As reported by Franz Fuchs, the special assistant to the Director of the Deutsches Museum Oskar von Miller, Miller used the German expression "precious [holy] relic" (*kostbare Reliquie*) in referencing the telescope of Simon Marius, an early seventeenth century German astronomer, as it was being transferred to the museum. This was the instrument with which Jupiter's four moons came into view to him virtually the same day as they did to Galileo.[16] In the same article by Fuchs, he himself used the identical word *Reliquie* to refer to lenses of a telescope of the German-Polish astronomer Hevelius of Danzig turned over to the Deutsches Museum in 1925 by the naturalists' society of Danzig.[17] The German usage by Miller and by Fuchs mirrors that used in the introduction to the 1876 London Special Loan Collection, presented in this dissertation as the originary event putting the Empire Germans on the path to historical scientific displays, which referred to the historical items from museums and private

[16] Franz Fuchs, "Der Aufbau Der Technischen Akustik Im Deutschen Museum," *Deutsches Museum, Abhandlungen und Berichte* 2 (1963): 16.
[17] Fuchs, "Der Aufbau Der Astronomie Im Deutschen Museum 1905-1925," 51.

collections as "sacred relics."[18] In German, *Relikt* generally connotes simply "remnant" or "remains", but Miller chose to use the word *Reliquie*, with its connotation of a religious nimbus. Scientific relics were by definition products of human activity, i.e. artifacts—but they were at least in the instance of the more important items, also "sacred" cultural goods for lovers of natural science. For the Germans, in particular, Germanic (and some other) scientific products were increasingly highly regarded during the Empire, as the official title of the Deutsches Museum, the Deutsches Museum of the Masterworks of Science and Technology, reveals. While it is important to recognize that many remnants of past scientific activity were scarcely suited to take on the role of sacred relics, and had to be content to remain being seen (and relating to the more significant original instruments) as merely artifacts, those high-profile objects which were the biggest crowd-pleasers at the displays were serving as scientific emissaries. They introduced the public to the increasingly widespread notion that science elevated Germany, and that its products deserved to be revered and regarded as the masterworks of genius.

There existed something of a hierarchy of the authenticity and the impact of the objects in the German Empire displays. Highest were the items that could be regarded, through age or through the fame of the scientist or the discovery with which they were associated, as holy relics. Next came the items of a more journeyman status, either not very old or merely good illustrations of some point *between* significant milestones in the development of a particular type of instrument or artifact—which in German could be referred to as *Relikte* but not as *Reliquie*. Possibly equal to these artifacts within the hierarchy of the display objects would have been replicas of the famous instruments of the past, while below both would have been the to-scale models representing an object of a historical interest.

[18] F.R. Sandford, "Introduction," in *Catalogue of the Special Loan Collection of Scientific Apparatus at the South Kensington Museum*, ed. South Kensington Museum (London: Printed by G.E. Eyre and W. Spottiswoode for H.M. Stationery Office, 1877), xiii.

PRIOR HISTORIOGRAPHY

EARLY HISTORY OF SCIENCE DISCIPLINE FORMATION

There is no good comprehensive account available in German of all facets of the German contribution to the spreading of the activity in, and the institutionalization of, the history of science during the second half of the nineteenth century up through the end of the Empire.[19] There has, further, been a decided neglect by some English-language accounts of this period's proto-institutionalization of the history of science discipline. I will focus on the underreported German Empire displays of the history of science in partial demonstration of my assertion that the existing historiography has tended to neglect the richness of the German attempts to present themselves as a people unusually skilled, both past and present, in studying, understanding and gaining mastery over the natural world.

Additional work will need to take place on German history of sciences a century ago. Some accounts, without mention of the German involvement, note the unfolding of the history of science before the late nineteenth century, before the German initiatives were so striking. The coverage of one prominent textbook of the history of science, Bowler and Morus's *Making Modern Science*, cites its emergence in its modern form initially during the eighteenth century: it was, they say, the Enlightenment's interpretation of the seventeenth century as a time of scientific revolution and a critical juncture in Western ideas that first stimulated a sense of the scientific past as history.[20] Richard Yeo identifies a further kindling of historical interest among British scientists of the early nineteenth century. He notes that practitioners started to draw out

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[19] For a contrasting view, see Nick Jardine, "Historiography of the Sciences - Research Guide," http://www.sites.hps.cam.ac.uk/research/hs.html.The writer claims that the only really substantial work on the nineteenth century consolidation of history of science as a discipline is Dietrich von Engelhardt's Historisches Bewusstsein in der Naturwissenschaft (Freiburg: Alber, 1979). This opinion cannot stand for every facet of the consolidation, however.

[20] Peter J. Bowler and Iwan R. Morus, *Making Modern Science: A Historical Survey* (Chicago: University of Chicago Press, 2005), 4.

the connections and breaks between their own work and beliefs and those of the initiators of the scientific revolution. Yeo attributes the increased British attention to the history of science to the specialization of science and the ongoing disappearance of the disciplinary unit known as *natural philosophy*.[21] However, these authors do not attribute any *institutionalization* of history of science to such early periods of interest.

Other authors primarily date its disciplinary formation to the post-World War I era. Among these, some accounts either simply do not extend their view of the history of science institutionalization far enough back, and thereby do not make enough of the Germans' heightened part in them, or they address what I call the "mature institutionalization" of the field without recognizing those elements of *early* institutionalization in which the Germans were so prominent. George Sarton, the Belgian known as the father of history of science for his publications and probably moreso for his 1913 founding and years-long editorship of the journal *Isis*, wrote an *apologia* in its first issue that, undoubtedly in the interest of speeding up the discipline's development, downplayed the contributions already made to it, especially by Germans. He averred that "[a]t this time, the history of science has still not been constituted into an independent discipline, having its own methods and working instruments: manuals, bibliographies, etc. It is scarcely taught in the universities...the general synthesis has still not been erected; the history of science remains yet 'an individual conception.'"[22] In the same place, Sarton's identified the main business of the emerging field to be creating syntheses, epoch by epoch, illuminated by the consideration of the state and the conditions of civilization. The field should endeavor to consider not only civilization, but also the history of technology, the history

[21] Richard R. Yeo, "Genius, Method and Morality: Images of Newton in Britain, 1760–1860," *Science in Context* 2, no. 2 (1988): 265.
[22] George Sarton, "L'histoire De La Science," *Isis* 1, no. 1 (1913): 10.

of religion, the history of the fine arts, and archaeological, anthropological and ethnological researches as far as all of these had a bearing on the evolution of science.[23]

More recent assessments appear in many instances to affirm Sarton's contemporary judgment of the lack of progress made at any time in the nineteenth and early twentieth century in developing the discipline of the history of science. In a series under the general editorship of George Basalla and William Coleman, in their introduction in 1977, speak of the only "over half a century [in which] an international group of scholars have been studying the historical development of the sciences."24 In a current publication, senior science scholar Helge Kragh considers that history of science first started to become academic in the first half of the twentieth century, and that this truly "caught on only after World War II."25 In a 2008 issue of Isis, in the introduction of a section comprising presentations at a Dibner-Marine Biological Laboratory (Woods Hole) symposium on the significance of the history of science, historian of biology (and then president of the History of Science Society) Jane Maienschein and philosopher of science George Smith date the academic discipline of history of science "from after World War II."26 More subtly, German natural science scholar Christoph Meinel, in a book chapter written in English, implies that while in Germany certain building blocks ("the first more durable structures") in the field of history of science were put in place during the German Empire, it developed there in too preliminary and piecemeal a manner to be said to have achieved more than incomplete stability there.27 Beginning with Sarton's, all these opinions, I submit,

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[23] Ibid.: 15.
[24] Series Preface by George Basalla and William Coleman in Richard S. Westfall, *The Construction of Modern Science: Mechanisms and Mechanics* (New York: Wiley, 1971), vii.
[25] Helge Kragh, "On Scientific Biography and Biographies of Scientists," in *Relocating the History of Science: Essays in Honor of Kostas Gavroglu*, ed. Theodore Arabatzis, Jürgen Renn, and Ana Simões (Cham: Springer International Publishing, 2015), 271.
[26] Jane Maienschein and George Smith, "What Difference Does History of Science Make, Anyway?," *Isis* 99, no. 2 (2008): 320.
[27] Meinel, "German History of Science Journals," 78.

shortchange what had already been done earlier, most comprehensively in Germany during the Empire. This dissertation provides evidence to qualify, if not contradict, Sarton's and Meinel's views: the steps in disciplinary formation traced here did not have to be revisited, but formed the basis for the ongoing and further developments that came together after the end of the German Empire to form an institutionally mature discipline in the decades following. Thus I claim that the proto-institutionalization, or early institutionalization, of the discipline occurred first there and then. Sarton, in his assessments, may have far understated the degree of the institutional constellation of a history of science discipline at least partly out of a concern to relentlessly prod further advance. Recent lack of an historiographical recognition of the great advance already made before the years of the First World War in this disciplinary constellation may derive more from distance in time from those earlier events and perhaps a desire to lend the majority of credit for it to a period more closely aligned with the present and the current cadre of the history of science specialists.

Developments in the formation of a community of scholarship and of organized activity in the history of science have figured in a number of recent accounts in German and in English, but in most of them the timeline is not centered on the years spanning the German Empire. In such accounts, the national identity of the actors and the incubation period highlighted varies considerably. Some secondary sources concede some activity was taking place in the German Empire, while de-emphasizing it. M. Osietzki, for example, in an article in the German journal Kultur und Technik, in referring evidently to German scholars, cites the innovation within technical historiography by the beginning of the twentieth century that incorporated accounts of the preconditions and impacts of technology. She is hinting at a German initiative which served to make such history more academically respectable.

Rachel Laudan recounts a centuries-long process of scientists writing about scientific history before 1913, in which a number of Germans figure individually. She does not allow, however, that there was a German move that could be distinguished from moves in other nations in the late nineteenth century. Regarding the Bavarian Academy of Science Historical Commission's series of histories that between 1864 and 1918 included twelve histories of science, highlighted below, Laudan contends that they lacked a particular "historiographic stamp".

Master historian of mathematics Christoph Scriba, in the context of his description of the origination of stand-alone international history of science congresses with the 1929 event in Paris, singles out the latter half of the nineteenth century as a period during which there was a spurt in the amount of published work tracing the development of various scientific disciplines (probably intending to include, within the German understanding of the term "science", also the disciplines economics, sociology, anthropology, and statistics—known in Anglo-American parlance as social studies). He implies, however, that this was not institution-building but an intellectual mold, especially since it was largely performed by *practitioners* of individual sciences (including mathematics) rather than by specialist historians of science.[28] His own focus on the first congresses specifically dedicated only to the history of science beginning in 1929 reflects on an important step in the full institutionalization of the discipline subsequent to that which this dissertation traces, but I feel does not diminish the argument for a German early institutionalization.

Andreas Frewer and Yvonne Steif, in a 2003 article, employ for the years 1896-1906 the term "*Kernphase"* (core phase) of the institutionalization of the discipline of medical history, as

[28] Christoph Scriba, "The Beginnings of the International Congresses of the History of Science," in *Final Report - Xviiith International Congress of History of Science: Hamburg-Munich, 1st-9th August, 1989*, ed. Fritz Krafft and Christoph Scriba (Stuttgart: Franz Steiner, 1993), 4.

the pivot period on to its full institutionalization; though at some points they seem to conflate medical history and the history of the natural sciences, it is nonetheless not clear that their intent is also to label those same years a core phase of the history of *natural science* institutionalization.[29] Arnold Thackray, more in line with the thesis for which this dissertation attempts to bring together evidence, designates Germans as the most active in the history of science in the late nineteenth century, but without explicit consideration of their contribution to discipline formation.[30]

That the history of sciences was achieving its proto-institutionalization phase most strongly in Germany suggests a need for new scholarship centered on Germany's early contribution to the discipline. I will document several aspects—using displays of historical scientific objects as my primary example—of an earlier attention in Germany to the history of science than what is included in some accounts of the discipline's creation. Including German scholarship in the history of sciences, I will show that it would be more accurate to speak of more than a century past as a time during which German (and to a considerable degree some other European nations') organized attention to the history of sciences has been underway.

The most numerous of the displays taking place during the German Empire were temporary. In the historiography of museums, the sub-areas of science museums or science and technology museums have often skirted any mention of the development of temporary displays.[31]

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[29] Andreas Frewer and Yvonne Steif, "Personen, Netzwerke Und Institutionen: Zur Gründung Der Deutschen Gesellschaft Für Geschichte Der Medizin Und Naturwissenschaften," *Sudhoffs Archiv* 87, no. 2 (2003): 180.
[30] Maria Osietzki, "Die Gründung Des Deutschen Museums: Motive Und Kontroversen," *Kultur & Technik.* 1984, no. 1/2 (1984): 8; Rachel Laudan, "Histories of the Sciences and Their Uses: A Review to 1913," *History of Science* 31, no. 91 Part I (1993): 29 footnote 85; Arnold Thackray, "History of Science," in *A Guide to the Culture of Science, Technology, and Medicine*, ed. Paul T. Durbin (New York: The Free Press, 1980).
[31] Charles R. Richards, *The Industrial Museum* (New York: The Macmillan Company, 1925); Brigitte Schroeder-Gudehus, Eckhard Bolenz, and Anne Rasmussen, *La Societé Industrielle Et Ses Musées: Demande Sociale Et Choix Politiques 1890-1990* (Montreux: Gordon et Branch, 1992); Wolfhard Weber, "The Political History of Museums of Technology in Germany since the Nineteenth Century," *History and Technology: An International Journal* 10, no. 1

In the historiography of exhibitions, attention is generally restricted to the large-scale exhibitions, and the small-scale exhibitions have generally fallen out of view. The result of these divisions, in regard to the displays of a scientific nature, is that the temporary or small-scale science exhibitions have failed to be reported in a sufficient degree. The dominance of the German displays during the Empire becomes more evident when the full range of displays, not just larger ones, is taken into consideration.

To address the lacks in the historiography, my study documents what should prove to be the greater number of the historical scientific displays, including the most significant, both temporary and permanent, during the German Empire (1871-1918). Within the few materials that treat the late nineteenth century surge in the German history of science scholarship, there has been no presentation and interpretation in the literature of historical scientific displays as a group phenomenon. In fact, they have previously been little-studied. Of the German Empire new museums whose remit is fully or partially history of science, historiographical coverage of the Deutsches Museum von Meisterwerken der Naturwissenschaft und Technik (the German Museum of the Masterworks of Science and Engineering), bolstered by its own publications, is substantial if insufficient; however, the scientific sections of the Germanisches Nationalmuseum (German National Museum) have received a far lesser amount of historiographical exploitation. During the time of the East German regime, there was also some very limited coverage of the history of the Treptower Observatory museum in state-authorized publications. Regarding temporary historical displays, there have been some general surveys of the London 1876 exhibition, largely lacking in details about the German participation, and Elisabeth Vaupel's two

(1993). Olaf Hartung, *Museen Des Industrialismus: Formen Bürgerlicher Geschichtskultur Am Beispiel Des Bayerischen Verkehrsmuseums Und Des Deutschen Berbaumuseums* (Köln: Böhlau, 2007).

publications addressing the German display at the St. Louis World's Fair.[32] These relatively few publications represent a spotty coverage of the phenomenon which does not give an overall sense of the significance of what transpired. There has not been consideration of such displays' role in the institutionalization of the history of science as a field, nor of their connections with other aspects of life during the German Empire. Here, my principal aim is to make good on these deficits.

I do not extensively detail other nations' early initiatives in the history of science. These would certainly be required in telling the complete story of its proto-institutionalization. The four factors considered above had certain parallels elsewhere to what took place in Germany, but to a lesser extent in at least three of the four: the impact on national self-image, the sense for history, and recent scientific achievement. Only regarding the role of the bourgeoisie is it arguable that nations other than Germany saw an impact equal to or possibly greater than that in Germany, and even in that respect there were particular conditions in Germany, specifically the bourgeoisie's reduced access to political influence during the Empire, that made it especially eager to take on cultural initiatives such as mounting exhibitions and displays, and providing leadership in the developing interest in the history of science.

The history of instruments is another area in which the historiographical literature has likewise given an insufficient recognition to early efforts in Germany, and in other nations. Commentators who have situated the rise of the systematic recording and valuation of historical scientific instruments only in *recent* decades have seemingly been unimpressed by any evidence of its earlier advent. For example, Christoph Meinel posits that after the early 1950s formation of

[32] Elisabeth Vaupel, "Chemie Für Die Massen: Weltaustellungen Und Die Chemieabteilung Im Deutschen Museum," *Kultur & Technik: Zeitschrift des Deutschen Museums München* 3 (2000); "Die Weltausstellungen Vor Dem Ersten Weltkrieg Und Ihre Bedeutung Für Die Popularisierung Der Chemie," in *Popularisierung Der Naturwissenschaften*, ed. Gudrun Wolfschmidt (Berlin: Diepholz, 2002).

a Scientific Instruments Commission of the International Union of History and Philosophy of Science (IUHPS), still "instruments were not valued as historically informative. It was left mainly as a matter for museums and their curators."[33] Robert Fox writes that "[i]n the mid-1980s… the community of academic historians that most curators wanted...to join, was seen as insensitive to the potential of instruments and apparatus as sources."[34] Referring to the history of instruments, R.G.W. Anderson speaks in 1993 of "…what has rightly been considered a neglected area in the history of science."[35]

A recent similar statement by current director and curator of the Whipple Museum of science at Cambridge University, Liba Taub, is that "some of this interest [by historians of science occurring now about scientific instruments] is due to the shift away from the study of the history of science as the history of ideas, to the study of the practice and culture of the scientific enterprise".[36] Taub has left untouched the earlier engagement of scholars and curators with scientific relics. She has seen both difficulties and signs of hope in their proper appreciation but all cast in a very recent time frame. For example, in 1998 Taub wrote: "Until recently, few of the collections of artifacts relating to STM [Science, Technology and Medicine] have been deliberately built up as historical collections."[37] She opined that now, as material culture draws an increased attention, more historians are involved in scholarship about scientific objects and their collection.[38] She then, three years later, introduced a focus section in *Isis* on scientific and

[33] Christoph Meinel, "Vorwart," in *Instrumente - Experimente: Historische Studien*, ed. Christoph Meinel (Berlin: Verlag für Geschichte der Naturwissenschaften und der Technik, 2000), 10.
[34] R. G. W. Anderson, "Introduction," in *An Apparatus of Instruments: The Role of the Scientific Instrument Commission*, ed. R. G. W. Anderson and Gerard L'E. Turner (London: Scientific Instrument Commission, 1993), 1.
[35] Robert Fox, "Collections and Research in the History of Science," Ibid., 19.
[36] Liba Taub, "'Canned Astronomy' Versus Cultural Credibility: The Acquisition of the Mensing Collection by the Adler Planetarium," *Journal of the History of Collections* 7, no. 2 (1995): 249.
[37] "On the Role of Museums in History of Science, Technology and Medicine," *Endeavour* 22, no. 2 (1998): 41.
[38] Ibid.

medical instrumentation, and adding to this emphasis on the *recent* engagement with scientific instruments, she wrote:

> [i]n 1994 the ninth volume of *Osiris*, focusing on instruments and edited by Albert Van Helden and Thomas L. Hankins, was published by the History of Science Society. This volume can be read as part of a larger trend during the 1990s, characterized by some as a 'pragmatic turn', in which historians of science were increasingly concerned with issues relating to scientific practice, including experimentation and instruments.[39]

She avers that the historians of science only rarely make instruments and museum artifacts the subject of thorough treatments.[40] She then, in a footnote, cites four edited collections that nonetheless show scholarship on scientific instruments from the last twenty years, as evidence of a recent increase.[41]

A working group under historian of science Ursula Klein in Germany provide another example of a near-contemporary account which, in tracing the history of attention to historical instruments as research objects, indicates that only in the recent decades has there been a major onset of interest. In a 2004-5 report, she made the point that over a period of about twenty years, instruments had been becoming a main subject of the group's investigation.[42] The implication of Taub and of the Klein group is that instruments began to receive serious attention only within a very recent period. They are not wrong about a recent upspike in the activity relating to instruments. But they, like many other authors, by writing in recent years about the current interest in the history of instruments, extend the timeline back only several decades (or even just a couple decades).

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[39] "Introduction: Reengaging with Instruments," *Isis* 102, no. 4 (2011): 689.
[40] Ibid.: 691.
[41] Ibid.: 690 footnote 5.
[42] Ursula Klein, "History and Philosophy of Laboratory Sciences -- Research Report 2004-2005 Max-Planck-Institut Für Wissenschaftsgeschichte," https://www.mpiwg-berlin.mpg.de/sites/default/files/2017-09/rr_04_05_complete.pdf., 127

Like Christoph Meinel, doyen of instrument studies Gerard l'Estrange Turner, characterizing the onset of inventories of scientific instruments, refers their genesis to the formation of the Scientific Instrument Commission in 1952.[43] In Turner's opinion, the incompleteness of almost all of these inventories, amounting to "probably nor [*sic*] more than a tenth of the instruments actually in the country concerned…" has been their chief drawback.[44] But, as with the neglect of German scholarship in, and displays of, scientific historical apparatus already more than one hundred years ago, one finds no mention of the pioneering proposal and preliminary inventory—however incomplete—on an Europe-wide basis begun over a century and a quarter ago by the German physicist and scientific historian Ernst Gerland.[45]

Writings such as the ones above imply that at most since sixty or seventy years ago, or sometimes for a far less lengthy period, scientific instrument studies have taken off. Some lament that the history of sciences over the years has not given more, or more careful, attention to apparatus. Of contemporary scholars responsible for the above quotations on the renaissance of attention to instruments, all but Christoph Meinel, Christoph Scriba and the Ursula Klein group are writing exclusively in English. This may perhaps be part of the reason for these (English-language) scholars' lack of attention to the displays and studies of instruments in Germany before, and just after, the start of the twentieth century. However, neither has the German research done much to document the concentration of the early German or other nations' activity in displays and research on instruments. During the German Empire, scholarship on instruments was contemporary with substantial activity in German historical scientific display of instruments and timepieces, books, manuscripts, maps and other artifacts—and all of this is underreported. I

[43] Gerard L'Estrange Turner, *Nineteenth-Century Scientific Instruments* (London: Sotheby, 1983), 252.
[44] Ibid.
[45] Ernst Gerland, "Beiträge Zur Geschichte Der Physik: Versuch Eines Verzeichnisses Der Bis Auf Unsere Zeit Erhaltenen Originalapparate," *Leopoldina* 18 (1882).

will provide evidence below of a vibrant enterprise during the Empire investigating and discussing historical scientific instruments.

THE HISTORIGRAPHY ON THE FAVORABLE FACTORS FOR THE RISE OF THE HISTORY OF SCIENCE

This dissertation complements and draws upon the historiographical literature addressing the four factors favorable for the rise of the history of science: the reign of science, the intellectual and social orientation to history, the contribution of the practice of science to the achievement of national identity, and the social-cultural role of the nineteenth century bourgeoisie.

The nineteenth century rise of science(s) is the common theme in David Cahan's book *From Natural Philosophy to the Sciences: Writing the History of Nineteenth-century Science* and David Knight's *The Age of Science: the Scientific World-view in the Nineteenth Century*. I have found useful a handful of sources that focus more particularly on (aspects of) the rise of science in nineteenth century Germany. The first two volumes of the four-volume work by John Merz, *A History of European Thought in the Nineteenth Century* (1904), and volume 3 in Franz Schnabel's four-volume *Deutsche Geschichte im Neunzehnten Jahrhundert* (*German History in the Nineteenth Century*), *Erfahrungswissenschaften und Technik* (*Empirical Sciences and Engineering*) (1948) are useful earlier works. More contemporary sources are the articles in the 1989 issue of *Osiris*, edited by Kathryn Olesko, titled *Science in Germany: the Intersection of Institutional and Intellectual Issues*.

Secondary sources useful in assessing the rise of history in German lands in the nineteenth century include the very early article (1844) of Karl Klüpfel "*Die historischen Vereine und Zeitschriften Deutschlands*" (The historical societies and periodicals of Germany) in

the first issue of the two-years-extant historical journal *Zeitschrift für Geschichtswissenschaft* and the 1915 publication *Kulturwissenschaft und Naturwissenschaft* (Cultural knowledge and natural knowledge) by Heinrich Rickert as well as the articles printed in 1959 in the centenary edition of the journal *Historische Zeitschrift*. In English, Georg Iggers's *The German Conception of History: the National Tradition of Historical Thought from Herder to the Present* deals directly with the German historical tradition. For the limited connections of the academic discipline of history with work in the history of science, see Christoph Meinel's book chapter "German History of Science Journals" and Bernhard vom Brocke's journal article *Das Elend der Wissenschaftsgeschichte in Deutschland - zur Entwicklung der Wissenschaftsgeschichte seit Ranke* (The Misery of the History of Knowledge in Germany – on the Development of the History of Knowledge since Ranke.)[46]

For the place of science in the attainment of German national identity, first see Constantin Goschler's book chapter "*Deutsche Naturwissenschaft und naturwissenschaftliche Deutsche*" (German natural science and scientific Germans) and Jutta Kolkenbrock-Netz's book chapter "*Wissenschaft Als Nationaler Mythos: Anmerkung Zur Haeckel-Virchow-Kontroverse Auf Der 50. Jahresversammlung Deutscher Naturforscher Und Ärzte in München (1877)*" (Knowledge as a national myth: a remark on the Haeckel-Virchow controversy at the 50th annual meeting of German Scientists and Physicians in Munich (1877).)[47] Another discussion, centering on Hermann von Helmholtz and Emil du Bois-Reymond's "scientific cosmopolitanism" and

[46] Meinel, "German History of Science Journals."; Bernhard Vom Brocke, "Das Elend Der Wissenschaftsgeschichte in Deutschland -- Zur Entwicklung Der Wissenschaftsgeschichte Seit Ranke, Insbesondere Im 20. Jahrhundert," *Mitteilungen - Osterreichische Gesellschaft für Wissenschaftsgeschichte* 13 (1993).
[47] Constantin Goschler, "Deutsche Naturwissenschaft Und Naturwissenschaftliche Deutsche," in *Wissenschaft Und Nation in Der Europäischen Geschichte*, ed. Ralph Jessen and Jakob Vogel (New York: Campus, 2002). Jutta Kolkenbrock-Netz, "Wissenschaft Als Nationaler Mythos: Anmerkung Zur Haeckel-Virchow-Kontroverse Auf Der 50. Jahresversammlung Deutscher Naturforscher Und Arzte in München (1877)," in *Nationale Mythen Und Symbole in Der Zweiten Hälfte Des 19. Jahrhunderts : Strukturen Und Funktionen Von Konzepten Nationaler Identität*, ed. Jürgen Link and Wulf Wülfing (Stuttgart: Klett-Cotta, 1991).

their German opponents, is provided by Daan Wegener's *Centaurus* article "Science and Internationalism in Germany: Helmholtz, du Bois-Reymond and Their Critics," which puts forth that "[n]ational stereotypes of science can be constructed and successful scientists can become objects of national pride. These stereotypes do not pre-exist but have to be actively cultivated."[48] For a more general treatment of the role of science in formation of national cohesion, see the 2009 *Osiris* issue titled *Science and National Identity*, edited by Carol Harrison and Ann Johnson.[49]

The role of the bourgeois in nineteenth century German society gets treatment in many secondary sources. A strong entry is the conference proceedings *Bürger und Bürgerlichkeit im 19. Jahrhundert*, edited by Jürgen Kocka.[50] David Blackbourn's *The German Bourgeoisie: Essays on the Social History of the German Middle Class from the Late Eighteenth to the Early Twentieth Century* provides an English-language overview.[51] Those sources treating the bourgeoisie in its relation to science are more limited: Andreas Daum's book *Wissenschaftspopularisierung im 19. Jahrhundert : Bürgerliche Kultur, Naturwissenschaftliche Bildung und die Deutsche Öffentlichkeit, 1848-1914* (Popularization of Science in the Nineteenth Century: Bourgeois Culture, Natural Scientific Refinement and the German Public, 1848-1914) and his article "*Naturwissenschaften und Öffentlichkeit in der bürgerlichen Gesellschaft: zu den Anfängen einer 'Popularwissenschaft' nach der Revolution von 1848*" (Natural sciences and public in bourgeois society: the beginnings of a 'popular science' after the revolution of 1848), along with Kurt Bayertz's chapter "Spreading the Spirit of Science: Social Determinants of the

[48] Daan Wegener, "Science and Internationalism in Germany: Helmholtz, Du Bois-Reymond and Their Critics," *Centaurus* 51, no. 4 (2009): 266.
[49] Carol Harrison and Ann Johnson, "Science and National Identity: Introduction," *Osiris* 24, no. 1 (2009).
[50] Jürgen Kocka, *Bürger Und Bürgerlichkeit Im 19. Jahrhundert* (Göttingen: Vandenhoeck & Ruprecht, 1987).
[51] David Blackbourn and Richard J. Evans, *The German Bourgeoisie: Essays on the Social History of the German Middle Class from the Late Eighteenth to the Early Twentieth Century* (London: Routledge, 1991).

Popularisation of Science in Nineteenth-Century Germany", give an overview of the reception of science among the bourgeoisie, with Daum's article also looking into how democratically-minded scientists served as agents for the public face of the bourgeoisie.[52]

THE METHODOLOGY OF THE DISSERTATION

Turning now to this dissertation's methodology, and in particular that of the science displays part of this study, I have exploited the contemporary media to acquire a sense for history of science exhibitions. Foremost in usefulness were the catalogues that accompanied most of the exhibitions. Reference to another exhibition appearing in a few of the catalogues helped me to extend my search. I have used newspaper and journal accounts of the displays, accounts which were in some instances affiliated with the exhibiting body, in others independent of it.

(Primarily bourgeois) exhibition culture, general in Europe and North America, was a predisposing factor for the historical scientific displays. What is remarkable about the museums of the nineteenth century also applies to the displays I am considering: they were a largely bourgeois achievement. I consulted materials on the German nineteenth century bourgeoisie generally and on the activity of Germany's scientific practitioners in the context of bourgeois representation and achievement. Drawing on the bourgeois involvement in the history of science displays contributes to telling a multi-dimensional story about them.

To see what further evidence for the advancing institutionalization of the history of science beginning in the late nineteenth century might be available, it was helpful to access the

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[52] Andreas W. Daum, *Wissenschaftspopularisierung Im 19. Jahrhundert: Bürgerliche Kultur, Naturwissenschaftliche Bildung Und Die Deutsche Öffentlichkeit, 1848-1914* (Munich: R. Oldenbourg, 1998). Andreas Daum, "Naturwissenschaften Und Öffentlichkeit in Der Burgerlichen Gesellschaft: Zu Den Anfängen Einer 'Popularwissenschaft' Nach Der Revolution Von 1848," *Historische Zeitschrift* 257 (1998). Kurt Bayertz, "Spreading the Spirit of Science: Social Determinants of the Popularisation of Science in Nineteenth-Century Germany," in *Expository Science: Forms and Functions of Popularization*, ed. Terry Shinn and Richard Whitley (Dordrecht: D. Reidel, 1985).

proceedings of the international scholarly conferences at which the history of science figured. The history of science was a prominent enough component at three pre-World War I conferences whose remit was broader than just history of science, that the history of science part of these events have been contemporaneously and subsequently referred to as the first three international *history of science* conferences. I have used their proceedings as well as those of certain other conferences to elaborate on the increasing level of an attention to the history of science in such venues. Online bibliographical searches brought to light specific items of published *scholarship* in journals presenting research in history of science, some of these journals operating in tandem with the permanent exhibition sites covered in the dissertation. I have consulted the foregoing items to help show that the Germans were an active force in the history of science scholarship. A symbiosis existed between the scholarship in the history of science and its display—a relationship brought home by my research ascertaining that several German display organizers were also history of science scholars—hence inclusion in this dissertation of some extended consideration of history of science scholarship.

I learned, through the work of Hermann Glaser, of the German Empire penchant for historical pageantry and memorials.[53] This certainly extended to the memorials to German scientists. Employing primarily web searches along with biographies, I found the locations and date of erection of many. In the nineteenth century before unification a selection of scientists were so honored, but during the German Empire the number of such commemorations substantially increased. Given the significance of the German Empire memorials in general for the intended effect of stirring patriotism, the conclusion is self-evident that authorities, publicists, and fellow practitioners commissioned memorials to (mostly deceased) German scientists, as

[53] Hermann Glaser, *Die Kultur Der Wilhelminischen Zeit Topographie Einer Epoche* (Frankfurt am Main: S. Fischer, 1984). See chapter 5, "Geschichte als Umzug oder: Die Verganglichkeit des Erbes".

they did other introductions of the history of science into public life, partly in order to evoke within the citizens of the new Germany a pride in belonging to its distinguished culture and in having a powerful state entity. With the distinctive place of science in modern German cultural life, recourse to its notables of the deep, and more often of the recent, past was an obvious way to instill widespread pride in German identity.

As members of the bourgeoisie collected donations for public memorials to German scientists, they were elevating their class profile within German lands. German scientists themselves sponsored and moved forward plans for memorials in the effort to render glory to their own specific (mostly bourgeois) professional groups and to science in general as a (particularly in the nineteenth century, largely bourgeois) calling.[54]

CHAPTER SUMMARY OF THE DISSERTATION

In Chapter I, the focus is on the various manifestations of German Empire interest in the history of science. I first look at the presentation of historical topics at German Scientists and Physicians meetings leading to the setting up of the world's first national society for the history of science. I follow with an account of the general rise in further German *scholarly* activity in the history of science, which certainly has not received all the attention it deserves. The Germans were the nineteenth century's great codifiers of knowledge (a project begun in the eighteenth century Enlightenment, notably in France) and they treated scientific knowledge as one of their

[54] Jacob Volhard and Emil Fischer, *August Wilhelm Von Hofmann: Ein Lebensbild Im Auftrage Der Deutschen Chemischen Gesellschaft* (Berlin: Friedländer, 1902), 127 which describes Hofmann's solicitation of contributions for two memorials for Justus von Liebig (1879 and 90) and one for Friedrich Wöhler (90). Richard Meyer, *Victor Meyer: Leben Und Wirken Eines Deutschen Chemikers Und Naturforschers, 1848-1897* (Leipzig: Akademische Verlagsgesellschaft, 1917), 192 detailing fellow chemists' fund-raising in commemorative busts for fellow chemists Friedrich Wöhler (deceased) and A.W. Hofmann (in celebration of his 70th birthday) and a painting of the aged (79 years) Robert Bunsen.

objects.[55] One of the fora for investigation of topics in the history of science was international scholarly congresses, which got underway at the turn of the twentieth century. The late nineteenth century saw a start in editing projects for the works of past German scientists. The publication of the earliest journals reviewing works in the history of science as a whole and presenting research took place in Germany. I discuss late nineteenth century German attention to the conservation of the relics of science and technology. Next, I cover German interest in the history of instruments. Finally, I treat memorials to scientists, another way Germans involved themselves in the promotion of the history of science.

In Chapter II and III, I take up details of sets of individual German historical scientific displays and exhibitions, characterizing and differentiating them. First is a chapter on the temporary displays at which German organizers participated. Following this is a chapter on the permanent exhibitions containing scientific relics. This part of the dissertation is almost exclusively based on original sources and so constitutes its core research element (although original sources were also frequently exploited in framing other passages of the dissertation).

Following this, in Chapter IV I provide a survey of nineteenth century German politics and society: the German political fragmentation and subjugation to Napoleon, industrial development and the strengthening of the German middle class, and science's relationship to German patriotism and nationalism are outlined. While laying out this outline, I bring in, where possible, diverse historical developments' connection with German science.

Chapters 5 and 6 treat two key aspects of the context to the German historical scientific displays. First, in Chapter V, to give a framework for the emergence of the German Empire

[55] Dieter Hein and Andreas Schulz, "Einleitung," in *Bürgerkultur Im 19. Jahrhundert. Bildung, Kunst Und Lebenswelt - Lothar Gall Zum 60. Geburtstag*, ed. Dieter Hein and Andreas Schulz (Munich: C. H. Beck, 1996), 14. Denise Phillips, *Acolytes of Nature: Defining Natural Science in Germany, 1770-1850* (Chicago: University of Chicago Press, 2012), 38.

history of science displays, I investigate the impact and penetration of science during the decades preceding and accompanying these displays. In this section of the dissertation, the depiction of the advance of science and the spread of an awareness of science to larger segments of the population will focus on the German lands as the exemplary locus of science of the second half of the nineteenth century. These trends proceeded in other places, but the treatment here will be restricted to Germany, a restriction justified by Germany's leading position in contemporary world science. I will show that Germany nursed specific international rivalries in which science came to be implicated, initially with France but then also with England.

No coverage of the German nineteenth century would be adequate without investigation of Germany's role not only as a land of science but also as a land of historical orientation and historical scholarship. The two came together in the pursuit of the history of science. Chapter VI treats the German intellectual context, specifically a turn to historical themes and preoccupations that was fairly general during the nineteenth century but was particularly marked in Germany, where it occurred in some domains already in the late eighteenth century.[56] I also suggest here an intriguing connection between the historical displays of scientific objects and the memorials to scientists during the German Empire.

Following these chapters is the dissertation's conclusion. I remark here on the connection between science and exhibition culture in Germany. The essential themes of the dissertation are restated, including lack of prior historiographical attention to historical scientific displays during the German Empire, and a return to the idea that the common understanding of the juncture at which the history of science institutionalized should be revised.

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[56] Franz Schnabel, *Deutsche Geschichte Im Neunzehnten Jahrhundert -- Die Grundlagen*, 4 ed., 4 vols., vol. 1 (Freiburg im Breisgau: Herder, 1948), 245. Glaser, *Die Kultur Der Wilhelminischen Zeit Topographie Einer Epoche*, 215. Sheehan, *German History, 1770-1866*, 542.

INTRODUCTION'S CONCLUSION

Historical scientific displays at which German organizers played a part may elude notice as a group in part because many of them were temporary, some were small, and a number of them were held outside Germany. The wide range of the types among them makes it difficult to subsume them under any generalizations. Nonetheless, by careful framing, I believe that I have shown that their commonalities are real and stem from shared causes. It is my hope that, similar to my reaction from immersing myself in contemporary materials on these German Empire displays, the reader will come away from the dissertation with a sense that they provide a surprisingly productive lens for interrogating the historical developments of their day. And, primarily, I maintain that they yield insight into the genesis of institutions giving a first shape to the discipline of the history of science.

PART I:
GERMAN HISTORY OF SCIENCE ACTIVITIES AND EXHIBITIONS

The next chapters, I through III, begin in Chapter I with a treatment of the overall extent and breadth of what Germans were doing, for the most part during the period of the Empire, to document, commemorate, and communicate science's past, with an emphasis on the German scientific achievements. These many activities together constitute the basis for my claim of a German primacy in the early institutionalization of the field of history of science.

A number of factors played an important role in bringing about a burst of activity in history of science during the Empire. Together, the different elements of this activity constituted an early institutionalization of the history of science discipline: with perhaps the exclusion of a brief period during the chaos of World War I and its aftermath in the early and mid-1920s, the discipline has built continuously since then on the initiatives taken, most widely in Germany, during the years from 1871-1918.

In giving the reasons that Germans led the way in early institutionalization of the history of science, I submit that the Germans viewed their own thought as being uniquely fundamental, and this self-assessment predisposed them to the undertaking of a reflection on the course of the development of their past. The remarks of one W.H. Lindley at a 1909 meeting of the council of the Deutsches Museum about German "*Gründlichkeit…Wissenschaft…Fleisses*" ("profoundness…learning…assiduity") in the past sixty years are fairly typical.[57] To the extent that such views of German thought were justified, something characteristically German may be in part responsible for the critical scientific practice that generated remarkable nineteenth century results. The German character likewise seems to have played a role in the German historical

[57] Anonymous, "Bericht Über Die Sechste Ausschusssitzung," *Verwaltungsbericht über das Geschäftsjahr und Bericht über die Jahresversammlung des Deutschen Museums* 6 (1909): 36.

reflection on the progression through which scientific ascendancy had been reached. For much the same reasons that Germans were leaders in this period in general historical scholarship, Germans would naturally have turned to the investigation and broad circulation of science's past.

In Chapters II and III I explore the range and chronology of German history of science displays, previously underreported. Temporary displays, covered in the second chapter, were a category of activities that were carried on throughout the period of the German Empire (and not before), reinforcing my supposition that there was a connection between a felt need to configure the identity of the new nation and the pursuit of activities in the history of science. I follow with a chapter treating newly-founded permanent exhibitions, that is, museums with a component of, or entirely devoted to, the history of science. The temporary displays and permanent exhibitions during the German Empire helped to build a network of people interested in the history of science, both the practitioners of science and non-practitioners, one of my criteria presented in the introduction for the (proto-institutionalization) of the field of history of science.

CHAPTER I:
GERMAN EMPIRE INVOLVEMENT IN THE HISTORY OF SCIENCE GENERALLY

Chapter 1 offers a portrait of the extent to which, during the German Empire, various individuals and groups launched or participated in events and sites treating aspects of the history of science. Such a review is relevant because, while there had previously been, in the German lands and elsewhere, scattered initiatives in the history of science, of which publications and some museum exhibitions are the primary examples, their numbers increased during the German Empire and became more continuous. These all contribute to justifying my claim that it was here and at this point in time that the (proto-)institutionalization of the field took place.

The chief points to be made in this chapter are that display, scholarship, commemoration, and journal and society foundation all took place during the Empire and formed a continuum that was built on subsequent to World War I to achieve the mature institutionalization of the field. The sources providing evidence for these occurrences, aside from the displays—whose sources will be covered in the following two chapters—are primary and secondary works on societies and congresses, library catalogues to trace book publications of individuals, a commemorative volume, online search engines to locate journal publications of individuals, and published reports on society meetings and proceedings of congresses.

A primary aim in the dissertation is to render the important German role in institutionalizing the history of science more apparent than it has been in previous historiography, in particular investigating the German Empire history of science displays and exhibitions. A secondary and related aim is to suggest, without giving equal attention to it, that the popularization of the history of science during the German Empire was an aspect of a portion of the activity in the history of science, among which certain displays and exhibitions were sites

of popularization. Potentially, popularization could entail a compromise between the austere laying out of scientific findings along with the introduction of the methods used to arrive at them, and the appeal of presenting iconic scientific exemplars or even of any objects giving off an aura of the scientific without their being explained or leading to any increase in understanding—in what we would term their educative benefit. Impressions generated by some displays and exhibitions may have served alternate purposes, such as convincing the public that science should get governmental financial support or highlighting to Germans that they had a strong heritage of science, while falling short in their educative impact regarding science's content and approaches.

Displays and exhibitions were among the most important exemplars of the Empire enthusiasm for reflecting on its past scientific glories and achievements. The German Empire involvement in the history of science, however, had many facets, and the material following will trace the multiplicity of the additional avenues through which the Germans pursued history of science. Of these avenues, underway in different nations, the German Empire's people participated in virtually all. The remainder of this chapter will attempt to build a general picture, along with what has already been said of displays, of the extent of the excitement during the German Empire about science's past. In these three chapters, I will specify which elements in the set of possible elements of (proto-)institutionalization of history of science given in the introduction the individual German history of science activities fulfilled.

PRESENTATION OF THE HISTORY OF SCIENCE TALKS

The occasional presentation of topics in the history of science at sessions during the annual meetings of German Scientists and Physicians represented the nascent formation of a

network of interested persons in the history of science, one of the criteria given in the introduction for the (proto-) institutionalization of the discipline of the history of science. These historically-centered sessions began at the fifth Scientists and Physicians meeting in 1826. Two examples among a great many are the following: Jessen in 1864 considered the development of the natural sciences since Bacon from the viewpoint of the German contribution; Ostwald spoke in1890 of the changes in chemistry since the achievements of Lavoisier, Volta and Berzelius.[58] The principal current investigator of the talks at the Scientists and Physicians meetings, Dietrich von Engelhardt, alleges that since the 1850s, the historical talks at the meetings were largely aimed at those topics with a direct *bearing on* present-day developments.[59]

While the bulk of the *section* talks was always devoted to contemporary scientific research, at the general sessions other topics were presented, and it was at the general sessions that historical topics surfaced rather often, where they served to some extent as diversions. The organizers for each meeting also programmed excursions to local sites of general and scientific interest and among these sites were at times a particular institution with some holdings of historical apparatus. Altogether, the meetings of Scientists and Physicians formed a seed-bed for the propagation of an interest in the history of science among (their very largely but not exclusively German) scientific practitioners. For a long time, nevertheless, the meetings saw no need for a designation of a specific section of talks embracing the history of science. Probably the network of interested persons was still too loose in earlier years for this to occur.

The role of history at German Scientists and Physicians meetings picked up during the middle of the German Empire period. With the unification of Germany, my contention is that

[58] Hermann Lampe and Hans Querner, *Die Vorträge Der Allgemeinen Sitzungen Auf Der 1.-85. Versammlungen Der Deutscher Naturforscher Und Ärzte 1822-1913* (Hildesheim: Gerstenberg, 1972), 9-11.
[59] Dietrich von Engelhardt, *Wissenschaftsgeschichte Auf Den Versammlungen Der Gesselschaft Deutscher Naturforscher Und Arzte 1822-1972* (Stuttgart: Wissenschaftliche Verlagsgesellschaft, 1974), 19.

likely there was a greater sense of their common historical roots among German scientists at the meetings. As reported below, the 1886 meeting included a small exhibit on the history of medicine. Three years later, the prominent German historian of medicine holding a university position in Vienna Theodor Puschmann gave a lecture at that year's meeting on the importance of an historical awareness of medicine's and natural science's past for scientific practitioners. Sections at the Scientists and Physicians meetings partially devoted to, and designated as, "history of science" began in 1894, within two decades of the start of a German involvement in temporary displays during the Empire. At that year's meeting, the history of medicine merited a shared section, and also, a display presenting artifacts from the history of medicine was mounted there. In 1896, again there was a shared section including the history of medicine, although its historical contents were sparing. In 1898, a breakthrough occurred, for there was a shared section that included the history of both medicine *and* natural science. Also at the 1898 meeting, a vast historical display corresponding to both these domains, covered below, took shape. In 1899 and again in 1900 there were shared sections including the history of medicine.[60] Those interested in the history of medicine took the opportunity at the general sessions of the meetings of making a case for the importance to all workers in the natural sciences of maintaining an historical awareness of science.[61] I posit that the onset of German temporary historical scientific displays and of additional permanent displays soon after German unification may also have played a role in consolidating interest in the history of science among more scientists, suggesting finally the formation of sections for the field at their national meetings.

[60] Karl von Sudhoff, "Aus Der Vorgeschichte Unserer Gesellschaft: Ein Rückblick," *Mitteilungen zur Geschichte der Medizin und der Naturwissenschaften* 3 (1904): 1-4.
[61] Frewer and Steif, "Personen, Netzwerke Und Institutionen: Zur Gründung Der Deutschen Gesellschaft Für Geschichte Der Medizin Und Naturwissenschaften," 189.

One further development in this period then set the stage for the formation of a German Society for the History of Medicine and Natural Sciences. The following paragraphs sketch out how a proposal on an international basis converted into a German national achievement. In 1899 the Dutch editor of the medical history and medical geography journal *Janus,* Hendrik Peypers, proposed an international history of medicine society, on whose guiding board the ambitious and German physician and storied historian of medicine Karl von Sudhoff was not included. Peypers made his proposal at one of that year's German Scientists and Physicians meeting sections, where he was involved as a foreign participant.[62] He had then received unanimous approval and gotten the commitment of people from several nations to be part of the work. Scholars of both the history of science and the history of medicine evidently directly took hold of the idea that they might be able to capitalize on an increase in interest to constitute their own international society and future congresses. Peypers had likely chosen to introduce within a *German forum* his path-breaking plan for a new kind of scientific society devoted to the historical pursuit of medicine because he anticipated a particular enthusiasm for his proposal among a German scientific audience.

A year later, in Section 5 of the 1900 Paris Comparative History Congress, to be covered below, Peypers, addressing his audience as "the Congress of the History of Science", returned to the matter, delivering what he called a re-statement of his earlier proposal. This time he called the proposed body "an international society for history and geography of medicine." He noted that the remit of his proposed society would also take in scientific disciplines neighboring to medicine, including biology, botany, chemistry, and pharmacy. In step with the Parisian meeting place of that year's Comparative History Congress, Peypers noted that the number of French

[62] Andreas Frewer and Volker Roelcke, eds., *Die Institutionalisierung Der Medizinhistoriographie: Entwicklungslinien Vom 19. Ins 20 Jahrhunderts* (Stuttgart: Steiner, 2001), 148.

figures willing to aid the project was as high as twenty: "[o]ur voices have ceased to resemble lonely voices that are falling off in the desert. Only, it's necessary to unite to make a showing. That's the catchword of our time." Peypers implicitly ascribed to the proposed society the responsibility for organizing future history of science congresses. He also proposed that his journal, *Janus*, could serve as its organ once the desired society was created.[63]

When, in response to Peyper's suggestions, Section 5 then took action, it formed a commission with the Frenchman Paul Tannery at its head to look into constituting an international society. Rather than restricting its scope to the history of medicine and allied sciences as Peypers had proposed, in the Section 5 deliberations the society was designated as generally covering history of sciences.[64] The commission was to proceed with four tasks: publishing the work presented in Section 5, studying the founding of an international society of the history of the natural sciences, publishing a journal for it, and providing for a succeeding International Congress for History of Science.[65] The use of the term "succeeding" indicates that already, along with Peypers, others who participated in Section 5 in 1900 also viewed that section as amounting to a first Congress specifically for the history of science.[66] The planning might be to continue to piggy-back onto future congresses of history and philosophy—this detail was not elaborated. Since one of the commission's envisioned tasks was to look into producing a journal, Section 5 was evidently predisposed to a journal with wider coverage of sciences than that which was provided in *Janus* with its limitation to the history of medicine (and closely allied sciences).

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[63] Hendrik Peypers, "Communications: La Société Internationale Pour L'histoire Et La Géographie Médicales," *Janus: Archives Internationales pour l'Histoire de la Médicine et la Géographie Médicale* 5 (1900): 434-35.
[64] Scriba, "The Beginnings of the International Congresses of the History of Science," 4.
[65] Anonymous, "Storia Della Scienze Fisiche, Matematiche, Naturali E Mediche (Atti Della Sezione Viii)" (paper presented at the Atti del Congresso internazionale di scienze storiche (Roma,1-9 aprile 1903), Rome, 1904), 7.
[66] Peypers, "Communications: La Société Internationale Pour L'histoire Et La Géographie Médicales," 434.

Before Tannery's commission could realize Peyper's plan at the international level, though, Karl von Sudhoff engaged in some backdoor subterfuge of it. Hurrying up the formation of a German national society, the first organized national or international body dedicated to history of science, he succeeded in implementing his own successful elevation to its leading position.[67] Sudhoff and his associates Georg Kahlbaum and Walter Pagel became the directorate of this first national society of the history of (medicine and) science, at which members gave talks on a regular basis and covered much more than just relatively recent scientific developments. Organization of a widely-based national society dedicated to the history of science was in my view the keystone in the early institutionalization of the history of science—the element given in the introduction that most directly signals German precedence.

In certain respects, the nationally-based drive forward of German history of science may even have retarded for a time the growth at the *international* level of a couple of potential institutions important to giving the history of science a permanent platform. It cannot be surmised that the proposal for an *international* society directly delivered a setback through erection of the *German* national society, but perhaps if Germans involved in that society had lent their efforts to the formation of an international society instead, the latter would have been achieved long before the constituting in 1928 of the International Academy of the History of Science at the Oslo (general) History Congress. The International Academy was at the outset a highly selective body. It was thus not the same idea that Peypers had initially had in mind, that of a gathering site for all those wishing to network in the history of medicine and allied scientific fields. The authentic sense of Peypers's initial proposal for an international society open to *all*

[67] Andreas Frewer, "Biographie Und Begründung Der Akademischen Medizingeschichte: Karl Sudhoff Und Die Kernphase Der Institutionnlisierung 1896-1906," in *Die Institutionalisierung Der Medizinhistoriographie : Entwicklungslinien Vom 19. Ins 20 Jahrhunderts*, ed. Andreas Frewer and Volker Roelcke (Stuttgart: Steiner, 2001), 114-18.

comers stood in abeyance for nearly two more decades until the formation in 1947 of the International Union of the History of Science.

One year after the German Society's origination, in 1902, it brought out its first publication, the *Mitteilungen* (*Communications*), whose focus was on reviewing works in the history of medicine and science (both journal articles and books) and on informing its readers of events pertinent to these. The *Mitteilungen* was the first publication in any country of a journal covering the history of science in general, an achievement that is noted in the dissertation introduction as one of the five building-blocks of the institutionalization of a field. While this journal was international in the reach of its reviews, it was the result of the formation of a first *national* history of science society, and may have seemed to lessen the imperative of getting an *international* society along with, presumably, a *multi-lingual* publication off the ground.

The new German Society for the History of Medicine and Natural Sciences made the decision to hold its yearly organizational meetings at dates abutting those of the Scientists and Physicians meetings. An annual stand-alone section in which to deliver history of science presentations within the annual Scientists and Physicians meetings was now guaranteed, since according to the Society of German Scientists and Physicians rules, any category of science with its own national society received this guarantee. With characteristic German administrative aplomb, in the new society's first organizational meeting in 1901, statutes were proposed and approved. The society decided to maintain its headquarters in Hamburg.[68]

In association with the 1902 Karlsbad meeting of Scientists and Physicians, the first stand-alone history of medicine and science section duly went forward with thirteen presentations. Of these, ten were devoted wholly to topics in medical history. Only two talks that

[68] One year later, France also founded a society for history of medicine, but its society did not purport to cover all of history of science as did the German society.

year had a purely non-medically-related topic in history of science: the first was titled "Goethe and [the chemist] Berzelius in Karlsbad", the second, "Should we write 'Copernicus' or 'Coppernicus?'"[69] The next year, eight of seventeen talks in the history of medicine and science section were on the history of science.[70] However, in several years preceding the onset of the First World War, the history of science content dropped sharply; so it was largely the history of medicine talks that carried the section. The impression of the primacy of the history of medicine in the new society up to the start of the First World War given by these numbers is reinforced by the fact that the talks on the history of medicine and science were held within the medical division rather than within the natural sciences division of these meetings. In these years, it was in the reviews published in its *Mitteilungen* that the society gave more attention specifically to the history of science in general than in the majority medically-themed talks delivered at the meetings.

The new society's strength grew rapidly. Reported at the end of 1904, membership had continually increased in the succeeding three years beyond the thirty-two who had answered the initial appeal to consider founding such a society.[71] In 1920, reporting on the society's first post-war meeting gave the current number of members as 223, down about 80 as a result of the war,[72] yielding a pre-war membership figure of roughly 300.

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[69] Albert Wangerin, ed. *Verhandlungen Der Gesellschaft Deutscher Naturforscher Und Ärzte 74. Versammlung Zu Karlsbad 21.-27. September 1902 Medicinische Abtheilungen*, vol. Zweiter Theil, II. Hälfte (Stuttgart: F.C.W. Vogel, 1903), 115.

[70] *Verhandlungen Der Gesellschaft Der Deutschen Naturforschern Und Ärzte 75. Versammlung Der Gesellschaft Der Deutschen Naturforschern Und Ärzte Zu Cassel 20.-26. September 1903 Medicinische Abtheilungen*, vol. Zweiter Theil, 2. Hälfte (Leipzig: F.C.W. Vogel, 1904), 94-95.

[71] Anonymous, "Protokoll Der Dritten Ordentlichen Hauptversammlung Der Deutschen Gesellschaft Für Geschichte Der Medizin Und Der Naturwissenschaften Zu Breslau Am 21. September 1904," *Mitteilungen zur Geschichte der Medizin und der Naturwissenschaften* 3, no. 13 (1904): 465.

[72] "Protokoll Über Die 13. Ordentliche Hauptversammlung Der Deutschen Gesellschaft Für Geschichte Der Medizin Und Der Naturwissenschaften Zu Nauheim," *Mitteilungen zur Geschichte der Medizin und der Naturwissenschaften* 19, no. 5 (1920): 231.

In the *Mitteilungen*'s first year, three issues together totaled over 270 pages, in the second year five issues and again in the third year five issues, with each of those years totaling nearly 500 pages. It continued publication through 1942, amounting to forty volumes. From the start, natural scientific reviews were arranged by categories: general, mathematics, physics and meteorology, chemistry, astronomy, geography and geophysics, mineralogy, technology, botany, and zoology. Some idea of the extent of these reviews can be gleaned from the fact that there were sometimes a number of publications reviewed within each category. Hundreds of publications, natural scientific and medical—including citations that did not give any details on the contents—were noted in each issue. The *Mitteilungen* proved to be an essential aid to the nascent field of history of science. Reporting on the 1929 Congress of History of Science two years after its occurrence, an article in the British journal *History* alluded to the importance of the *Mitteilungen*, "first published in 1902, and still indispensable for bibliographical purposes."[73]

Further, the continuation of the German national society's meetings and its publication through a portion of the Empire, the difficult Weimar years and the bulk of the National Socialist years testifies that the society's contributions to instituting a history of science discipline were ongoing, and therefore that the society should receive substantial credit for being a key building block in its formation.

Once the initial step to form an organization for history of science had been taken on the national level, within the decade three other German regional/local societies addressed to similar topics set up operations: the Berlin Society for the History of the Natural Sciences and Medicine in 1906, in Jena in 1908 the Study Group for History of Chemistry of the Association of German Chemists, and in 1911 the Rhenish (West German) Society for the History of Natural Science,

[73] W. Adams, "The International Congress of the History of Science and Technology," *History* 16, no. 63 (1931): 202.

Medicine and Technology based in Düsseldorf.[74] It seems apparent that the formation of these additional groups was inspired by the establishment of the German national society. All of these bodies attest to a mounting interest and activity in the history of science during the German Empire, and to the enlarging network of persons interested in, and indeed closely following, the new field.

FURTHER HISTORY OF SCIENCE SCHOLARSHIP

Historian of science Arnold Thackray maintains that the palm for ardent pursuit of scholarship in history of science during the nineteenth century goes to Germany.[75] Published scholarship is one of the elements of (proto-institutionalization) outlined in the introduction.

Some articles devoted to history of a science appeared in German journals devoted to contemporary science. Since already about the middle of the nineteenth century, the *Archiv der Mathematik und Physik* and the *Zeitschrift für Mathematik und Physik* accepted historical articles.[76] In the latter journal, Moritz Cantor served as an editor of the literary and historical offerings from 1859—they appeared as a separately numbered supplement from 1875.

From 1877 Cantor edited a journal specifically devoted to mathematical history, the *Abhandlungen zur Geschichte der Mathematik* (*Essays on the History of Mathematics*).[77] Although this journal did not give coverage to the history of science overall, it surely spurred dissemination of interest in the history of sciences more generally, helping to broaden the network of persons interested in the field, another of the elements of (proto-)institutionalization.

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[74] Anonymous, "Fachgruppe Für Geschichte Der Chemie," *Zeitschrift des Vereins Deutscher Chemiker: Teil A* 23 (1908): 1295. Lampe and Querner, *Die Vorträge Der Allgemeinen Sitzungen Auf Der 1.-85. Versammlungen Der Deutscher Naturforscher Und Ärzte 1822-1913*, 43.
[75] Thackray, "History of Science," 10.
[76] Laudan, "Histories of the Sciences and Their Uses: A Review to 1913," 30 footnote 93.
[77] Joseph Dauben, "Historia Mathematicae: The History of Journals for the History of Mathematics," in *Journals and History of Science*, ed. Marco Beretta, Claudio Pogliano, and Pietro Redondi (Florence: L. S. Olschki, 1998), 9.

The journal *Janus: archives internationales pour l'histoire de la médicine et pour la géographie médicale* (*Janus: international archives for history of medicine and for medical geography*—originally published from 1846 as *Janus: Zeitschrift für Geschichte und Literatur der Medicin*), was revived in 1896; under the editorship of Hendrik Peypers, during the first decade of its resumed publication, more articles on topics in history of medicine in German (33%) appeared than in any other language.[78]

In 1906 the first institute of the history of medicine was formed at the University of Leipzig under the directorship from its inception to 1925 and again from 1932 to 1934 of Karl von Sudhoff. This institute was a site intended to sponsor scholarly research. Soon its products were appearing in the journal *Archiv für Geschichte der Medizin* (*Archive for the History of Medicine*), published under that name from 1907 to 1928 with Sudhoff either as its sole editor or (during the period 1926-1928) as its co-editor, then beginning in 1929 under a different pair of editors as *Sudhoff's Archiv für Geschichte der Medizin*, and finally, beginning in 1934, with Sudhoff reinstated as its editor through 1936, as *Sudhoff's Archiv für Geschichte der Medizin und der Naturwissenschaften*. The institute also published a series of monographs entitled *Studien zur Geschichte der Medizin* (*Studies on the History of Medicine*), appearing from 1907 to 1937. With its specialized publications, the institute generated interest in the history of one particular science in Germany, as the *Abhandlungen zur Geschichte der Mathematik* had already been doing. While not bringing together a network of *all* those with disparate interests in the history of science, the publications of the institute were one node leading to formation of a more general network of those with interests overall in the history of science.

[78] Bert Theunissen, "Journals of the History of Science in the Netherlands," in *Journals of History of Science*, ed. Marco Beretta, Claudio Pogliano, and Pietro Redondi (Florence: L.S. Olschki, 1998), 203.

In 1909, under the editorship of three Germans, the state scientific official Karl von Buchka, the medical and scientific historian Hermann Stadler, and Karl von Sudhoff, the *Archiv für die Geschichte der Naturwissenschaften und der Technik* (*Archive for the History of the Natural Sciences and of Engineering*) was begun, with a contributing editorship of figures from all over Europe and the United States known for their work in the history of science. In intent, this was to be the first such scholarly research-centered publication covering the whole gamut of the sciences, and it was initially positioned to help create a trans-national network of interested people by publishing research articles in English, French, and Italian as well as in German.[79] The first issue's introduction made clear the importance that the editors attached to the (proper) historical method as directed to studies of the sciences.[80] The *Archiv* combined two of the model types the Frenchman Paul Tannery, as the first head of the early international commission to promote history of science conferences from 1900, had sketched out as possible for a history of science journal, being both an international journal and one supported, for issues four through nine, by a society, the Berlin Society for the History of the Natural Sciences and Medicine. Thus in this area of institutionalization, Germans had again seized the initiative.

However, already by appearance of the issues of volume two in 1909, the articles were exclusively in German, so the attempt to make the journal linguistically international was not met with much success. Publication of the *Archiv für die Geschichte der Naturwissenschaften und der Technik* may, beyond the publication of the German Society's *Mitteilungen*, have further forestalled the idea for an *international* journal to be published in connection with the Commission for International Congresses of History of Science formed in Section 5 of the 1900 Paris Comparative History Congress. From 1927 to 1931, the publication was issued under the

[79] Karl von Buchka, "Zur Einführung," *Archiv für die Geschichte der Naturwissenschaften und der Technik* 1 (1909): 7.
[80] Ibid.: 3.

name *Archiv für Geschichte der Mathematik, der Naturwissenschaften und der Technik***,** and from 1931-1942 as *Quellen und Studien zur Geschichte der Naturwissenschaften und der Medizin*, whose publication by that point had been taken over by the Leipzig *Institut für Geschichte der Medizin und der Naturwissenschaften* (Institute for the History of Medicine and the Natural Sciences).

Assessing Germany's early institutionalization of the history of science, one can say that the level of its contribution on an international level could have even been somewhat greater, had it managed to continue with the *Archiv* to be a multi-lingual channel between all scholars of the history of science. Still, as the first vehicle exclusively for publishing research in the history of science as a composite field, the initiation of the *Archiv* went a step further in showing that Germans led the way in periodical publishing in the history of science, also one of the elements given above for its (proto-)institutionalization.

Alongside the media of presentations at society meetings and scholarly periodicals, scholarship in the history of science was also presented at congresses. Research in the history of science in aggregate constituted a small fraction of the massive overall total of historical research performed in Germany in the nineteenth century. Nevertheless, history of science, as we will see, was now seen to be important enough to have a place allocated to it at congresses of *general* history and of philosophy.

International academic congresses were themselves an innovation of the nineteenth century. The first international scientific congress, devoted to chemical nomenclature, was held in 1860 in Karlsruhe, Germany. Subsequently, world's fairs provided the occasion for a number of scholarly congresses. In an effort to make the occasion of a world's fair intellectually comprehensive, for example, organizers of the Paris-based world's fair of 1889, centenary year

of the French Revolution, introduced seventy congresses into the proceedings. At the 1900 world's fair, also held in Paris, celebration of the turn of the century included a host of like events. One source has determined that between 1860 and 1909 there were a total of 2135 international conferences among scholars, officials and the like.[81]

The connection between the looming turn of the century and a germinating environment for the history of science that was seen in Germany at the Physicians and Scientists meetings, in scholarly writings appearing in journals, and in memorials to scientists also took hold at international congresses organized just before, at, or just after the turn of the century. The first to be considered here was in 1897, after which three more were timed to coincide with the 1900 Paris International Exhibition (world's fair). In the years immediately following, the history of science (including mathematics and medicine) received a section or part of a section within other congresses. All these sites, with more or less German participation, contributed to the extension of the network of people jointly interested in the history of science. While Germans were only one among a number of the national groups delivering talks at the congresses within their history of science sections, overall such German participation in congresses helps make the case that it was Germans who exhibited the widest *range* of activities involving history of science - another of the criteria given in the introduction for their (proto-)institutionalization of the field.

At congresses of mathematics, beginning with the 1897 First International Congress of Mathematics held in Zurich, the history of the field was allocated its own section. In preparation for the 1897 congress, a circulating letter went out, in which the business of the event was described as including history along with pure science. The German mathematician Adolf Hurwitz delivered a general session talk on the recent development of analysis, with a cursorily

[81] W. Boyd Rayward, "International Exhibitions, Paul Otlet, Henri La Fontaine and the Paradox of the Belle Époque," in *Information Beyond Borders: International Cultural and Intellectual Exchange in the Belle Époque*, ed. W. Boyd Rayward (Burlington, VT: Ashgate, 2014), 6, 12.

historical approach. "History and Bibliography" of mathematics was one of five specialized sections: three of the Congress's thirty-four section talks were given in this section, and of them, two were in German—these, though, by a Dane and a Swede![82] This was a small start, but a suggestive one.

Three history of sciences sections were put on at three international congresses held in conjunction with the 1900 Paris World's Fair: again at the second International Mathematics Congress, but now also at The Second International Congress of Comparative Historical Studies and at the First International Philosophical Congress. The presentations accorded history of science at these events was largest overall at the Congress of Comparative History, with twenty-six talks.

The 1900 Comparative Historical Studies Congress at Paris featured a host of historical talks in various aspects of science given by scholars from a range of countries, as well as some organizational proposals for international work. The Congress was actually the second international congress addressing history, but its 1898 predecessor in the Hague had been specified as limited to Diplomatic History. German, English, and American attendance at the Paris History Congress was noted as low; overall the attendance reached over eight hundred fifty, but one source claimed that only around two hundred were actually active.[83] For the history of science, Section 5, the congress marked a brisk move forward. Of eight sections, only the History of Music, with thirty-eight, had more presentations than the History of Science's twenty-six, an impressive showing and a sign of the level of the activity in the field. Of the twenty-six,

[82] Ferdinand Rudio, *Verhandlungen Des Ersten Internationalen Mathematikerkongresses in Zürich Vom 9. Bis 11. August 1897* (Leipzig: B. G. Teubner, 1898), 10.
[83] Anonymous, *The Nation* 71 (1901): 127.

five were on the history of mathematics and four on the history of medicine.[84] Probably due to the low enthusiasm generated in Germany by the Congress organizers, only two Germans gave talks in the History of Science Section, Moritz Cantor regarding the life of the German mathematician Gauss, and Siegmund Günther on the slow onset of Copernican views from the sixteenth until the early eighteenth centuries. The fairly tepid German response at this congress's history of science section was for the most part improved on at subsequent congresses.

The 1900 Mathematics Congress put the history of mathematics in a prominent spot, with some historical content in three out of the four plenary speeches, two of them being patently historical talks. In addition to the opening Plenary Session talk given by Moritz Cantor on Historiography of Mathematics, the other fully historical plenary talk was on the long correspondence between the German mathematician Karl Weierstrass, who had died three years earlier, and his Russian female colleague Sofia Kovalevskaya.[85]

The 1900 Paris Philosophy Congress also had a Logic and History of the Sciences section. At its opening, Paul Tannery proclaimed: "It is in the past century that researchers [in science and mathematics] have delivered to philosophers the most important findings for their development. Count all the potent geniuses who from the start of the century to its conclusion have attacked the conception [for example] of space." "Who will escape," he added, "the importance of this history" of the evolution of mathematics?[86]

Nine talks relating to history of science were given in the Philosophy Congress. It is probably not surprising that the majority of these talks were primarily mathematical, given their

[84] Helene Gispert, "Les Debuts De L'histoire Des Mathematiques Sur Les Scenes Internationales Et Le Cas De L'enterprise Encyclopedique De Felix Klein Et Jules Molk," *Historia Mathematica* 26 (1999): 348; Anonymous, "Annales Internationales D'histoire: Paris 1900 Histoire Des Sciences" (Paris, 1901), i [no actual pagination], 347.
[85] José Sanchez-Ron, "From the Private to the Public: The Road from Zürich (1897) to Madrid (2006)," in *International Congress of Mathematicians (Madrid, August 22 - 30, 2006)*, ed. Marta Sanz-Solé (Madrid: European Mathematical Society, 2006), 780.
[86] Paul Tannery, "Logique Et Histoire Des Sciences (Section 3 of Congrès International De Philosophie)," *Revue de metaphysique et morale* 8 (1900): 540.

common ground with philosophy in the field of logic. There were just two historical talks on other specific sciences.[87] Moritz Cantor and Siegmund Günther, the same two Germans who had given talks at the 1900 History Congress, presented among the Section's mathematical talks on "Origins of the infinitesimal calculus" and "On the history of the origins of the Newtonian law of gravitation and of its influence on the development of mechanics and physics".[88]

When the organizers of the 1903 Rome Congress of Historical Sciences made known that they would give due recognition to the history of science as a division of the congress, Tannery decided it would be in the best interest of the field that a next gathering of its practitioners would take place as a larger conference's division, as it had done at the international Congress of the Historical Sciences at Paris three years before.[89] The overall German presence at the Rome Congress of Historical Studies was again low, but this time, unlike at the 1900 Paris History Conference, there was a good German-language representation in the History of Science section. Further, German scholarship in the history of science was honored by having four German-language session presidents out of the nine total sessions of the Section.[90]

In the Rome Congress's Section 5, the history of mathematics drew considerable attention, with ten out of the Section's thirty-four presentations.[91] Moritz Cantor and Anton von Braunmühl, though unable to attend the Rome Congress, sent mathematical-historical papers to be read, while Karl von Sudhoff gave a talk on the literary legacy of the sixteenth century

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[87] Anonymous, *Philosophy Review* 3 (1900): 361.
[88] E.O. Lovett, "Mathematics and the International Congress of Philosophy in Paris, 1900," *Bulletin of the American Mathematical Society* 7, no. 4 (1901): 159.
[89] Paul Tannery, "Propositions Ayant Pour but D'activer Le Progrès De L'histoire Des Sciences," in *Congresso Internazionale di Scienze Storiche (Roma 1-9 Aprile 1903)* (R. Accademia dei Lincei, 1904), 8.
[90] Karl Dietrich Erdmann et al., *Toward a Global Community of Historians: The International Historical Congresses and the International Committee of Historical Sciences 1898-2000, Translated by Alan L. Nothnagle* (New York: Berghahn Books, 2005), 16.
[91] "Storia Della Scienze Fisiche, Matematiche, Naturali E Mediche (Atti Della Sezione Viii) Volume 12," in *Atti del Congresso internazionale di scienze storiche (Roma, 1-9 aprile 1903)* (Rome: Tipografia della Reale Accademia dei Lincei, 1904).

German-Swiss icon Paracelsus, known for his early chemical knowledge. Siegmund Günther talked on the historical development of the astronomical-geodetic instrument called the "Jacob's rule".[92]

The Section 5 Commission for International Congresses in History of Science created at the 1900 International History Congress was reconstituted at the 1903 Congress in Rome. Among the seven permanent commission members elected now, Sudhoff and Günther represented Germany and K. Benedikt Austria, while G. Eneström of Stockholm, editor of the mathematical history journal *Bibliotheca Mathematica*, and H.G. Zeuthen of Copenhagen, also an expert on mathematical history, also added to the formation of a German-speaking bloc.[93] Now German-speakers and the Italians were the most represented language-blocs. Germans' significant participation in this commission is another demonstration of Germany's having had the widest range of important activity in the history of science during the Empire.

Tannery judged the founding of a *national* journal of the history of sciences which would allow inclusion of substantial original research (in addition to the reviews of history of science publications started in the German Society for the History of Medicine and Natural Sciences' *Mitteilungen* in 1902) to be problematic because it would set one country ahead of all others in the discipline. This left the option of a journal as the organ of an *international* society for the history of science. Clearly, with Tannery this idea of a society and a journal was no longer restricted to the history of medicine, as it had been during Peypers's initial proposals of 1899 and 1900. However, despite Peypers's and Tannery's admonitions, the *Archiv für die Geschichte der Naturwissenschaften und der Technik*, a national journal in the sense that its three editors were

[92] Ibid., xi, xvi.
[93] Edouard Claparède, *Congrès International De Philosophie: Iime Session, Tenue À Genève Du 4 Au 8 Septembre 1904: Rapports Et Comptes Rendus* (Geneva: H. Kündig, 1905); "Storia Della Scienze Fisiche, Matematiche, Naturali E Mediche (Atti Della Sezione Viii) Volume 12," vi-vii.

German citizens, in 1909 was the first research-based history of science journal to get off the ground (followed in 1913 by *Isis*).

Within a year of the Rome Congress, the 1904 Geneva International Philosophy Congress also provided a Section 5 for the History of the Natural Sciences. At the first two of the three sessions of the Congress, two participants heading the new German Society for the History of Medicine and the Natural Sciences, Karl von Sudhoff and Georg Kahlbaum, were elected session chairmen.[94]

Thirteen presentations were given in the Section 5 sessions, out of which all but three were on natural and general sciences topics, with the remainder on medical topics. The proportion here of medical to natural scientific presentations was inverted in comparison to the same year's history of science presentations at the German Scientists and Physicians meeting. There, out of seventeen presentations, all but five were medical in nature.[95] There were three German presentations, only one of them medical.

The International Commission for the Congress of the History of Science designated Section 5 of the 1904 Philosophy Conference as officially constituting *their* Congress's third meeting, with the conference proceedings subtitling its Fifth Section "the third international congress of history of science".[96] Also, the 1904 *Revue de Synthèse Historique* designated 1900, 1903 and 1904 as the first three congresses of the history of science, while the German Society's 1904 *Mitteilungen*, in a report on the 1904 International Philosophy Congress, designated the History of Science section as concurrently the third International Congress of the History of

[94] Anonymous, "Aus Der 5. Sektion Des Ii. Internationalen Kongresses Fur Philosophie in Genf, 4. Bis 8. September 1904 Geschichte Der Naturwissenschaften Zugleich 3. Internationaler Kongress Fur Geschichte Der Naturwissenschaften," *Mitteilungen zur Geschichte der Naturwissenschaften und der Medizin* 3, no. 5 (1904): 473.
[95] Ibid.: 473-80.
[96] *Mémoires de la Société des sciences physiques et naturelles de Bordeaux* 6, no. 4 (1908): 315.

Science.[97] Thus, already by 1904 there was some consensus about which of the conferences/congresses at which the history of science had played some demarcated role was important enough to be considered as history of science congresses *tout court*.

When the Paul Tannery died at the end of 1904, Sudhoff was unanimously elected his successor as the President of the International Commission for the History of the Natural Sciences.[98] This election definitively demonstrated that the Commission had gone beyond its initially predominantly French character.

In 1904, the third International Congress of Mathematics at Heidelberg provided a major forum for the history of mathematics. The Congress's fifth section, out of six total, was on the History of Mathematics, with eleven presentations.[99] At the Congress's opening, two historic display items in the Congress's exhibition were mentioned: a brief presentation was given on the original calculating machine of Leibniz by Carl Runge from Munich, who accompanied the machine to the Congress; the second item was a famous historic mathematical model designed by Christian Wiener of Karlsruhe.

It was the intent of the Commission of the History of Science in 1904 that the next semi-official history of science congress be attached to the Berlin Third International Congress of Historical Sciences, originally scheduled for 1906 but then delayed to 1908. Presumably the initial idea of the Commission had been for this Congress to have a section exclusively devoted to the history of science, but in the event this did not happen. Instead, the History of Mathematics, Natural Science and Medicine convened as a subsection under the section titled

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[9797] Henry Michel, "Nécrologie: Paul Tannery," *Revue de synthèse historique* 9 (1904): 380. Anonymous, "Aus Der 5. Sektion Des Ii. Internationalen Kongresses Fur Philosophie in Genf, 4. Bis 8. September 1904 Geschichte Der Naturwissenschaften Zugleich 3. Internationaler Kongress Fur Geschichte Der Naturwissenschaften," 472.

[98] Anonymous, "Von Der Internationalen Kommission Für Geschichte Der Naturwissenschaften," *Mitteilungen zur Geschichte der Medizin und der Naturwissenschaften* 4, no. 3 (1905): 473-74.

[99] A. Krazer, *Verhandlungen Des 3. Internationalen Mathematiker-Kongresses in Heidelberg Vom 8. Bis 13. August 1904* (Leipzig: Teubner, 1905), ix.

Cultural and Intellectual History of the Middle Ages and the Modern Period. Sudhoff and Günther had been delegated as the German Society for the History of Medicine and Natural Sciences' representatives in the Congress preparations.[100] If the 1898 and 1900 International History Congresses were retrospectively viewed as struggling to attract participants, and the more popular 1903 Rome Congress as lacking in its level of scholarship, the 1908 Berlin Congress satisfied on both counts.[101] There were sixteen talks planned in the History of Science subsection, six of them by people connected with the German Society for the History of Medicine and the Natural Sciences, including by its members Ferguson, a Scot, and Györy, a Hungarian.[102]

In Rome in 1908, the fourth International Congress of Mathematical Sciences was held. Then the fifth, the last pre-war Congress, was held in Cambridge in 1912. At both of these meetings, historical talks were held, and at Cambridge books, models and calculating machines were display items.[103]

In 1913 the fourth Congress of Historical Studies was held in London. Only a sub-section was devoted to the history of Exact Sciences, Natural History and Medicine within a section titled History of Mediaeval and Modern Civilization. There were a total of nine presentations in the sub-section; all but one was given in English.[104] Thus, the international stamp of history of science scholarship was little represented at this event on the eve of World War I. *Nature*'s account of the event spoke of its faulty organization and the lack of foreign-language capacity in Britain as being negative factors in gaining for the congress its due consideration in that

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[100] Anonymous, *Mitteilungen zur Geschichte der Medizin und der Naturwissenschaften* 7 (1908): 131.
[101] Erdmann et al., *Toward a Global Community of Historians: The International Historical Congresses and the International Committee of Historical Sciences 1898-2000, Translated by Alan L. Nothnagle*, 41-57.
[102] Anonymous, *Programm Des Internationalen Kongresses Für Historische Wissenschaften. Berlin, 6. Bis 12. August 1908* (Berlin: Universitäts-Buchdruckerei von G. Schade (O. Francke), 1908), 14.
[103] Guillermo Curbera, "Icm-Ems Newsletter," http://euler.us.es/~curbera/historymath/ICM-EMSNewsletter.pdf.
[104] Anonymous, "Rapports: International Congress of Historical Studies: Programme of Papers & List of Readers," http://babel.hathitrust.org/cgi/pt?id=uc1.b3443611;view=1up;seq=1.

nation.[105] There were no German or French presentations in the history of medicine and science sub-section.

International congresses treating the history of science did not attain full development during the German Empire. Though there had been by 1918 a number of congresses in which the history of science featured, nonetheless, these were all congresses whose overarching contents were broader than the history of science: the latter was simply included as one among the sections or subsections. Things began to change only a decade after the end of the First World War. In 1928 in Oslo, at the second post-war international historical congress, as on a number of occasions previously, provision was made for a section partly focused on the history of science, including medicine, but also including the history of literature.[106] But furthermore, in Oslo an International Committee for the History of Sciences formed—a successor to the pre-war Commission for the History of the Natural Sciences—among whose ten members there were the German historian of medicine Karl von Sudhoff, the historian of biology Julius Schuster of Berlin, and the Swiss scholar of medical history then active in Leipzig, Henry Sigerist. Sudhoff, formerly President of the Commission for the History of the Natural Sciences from 1904, thus formed a link with the pre-World War I international infrastructure for the history of science. This committee then forwarded the idea for an (unattached) international Congress of the History of Science, the first congress exclusively for the history of science, which was held the following year in Paris. A further internationally-constituted committee then took over the duties of actually planning future bi- or tri-yearly congresses for the history of sciences. Germany's representation on this committee was still larger than that of any other nation.

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[105] "The International Congress of Historical Studies," *Nature* 91 (1913): 165-66.
[106] Karl Dietrich Erdmann et al., *Toward a Global Community of Historians: The International Historical Congresses and the International Committee of Historical Sciences 1898-2000, Translated by Alan L. Nothnagle* (Berghahn Books, 2005), 123. A. F. Pollard, "Bulletin of the Institute of Historical Research: The Oslo Conference," *Historical Research* 6, no. 17 (1928): 69.

Germans, personae non gratae at most international scholarly events since the start of the First World War until the 1928 Oslo historical conference, were thus reinstated for the post-war (re-)start of congresses exclusively devoted to the history of science from 1929 forward.[107] Further, the German Karl von Sudhoff was elected the President of the Council of the International Committee after the 1931 London congress. So despite their loss of (and the blame attributed to Germany for) the world war, after a delay, Germans were being re-integrated to a substantial degree into the world intellectual community, including into that part pertaining to the history of science. Gone, though, in this post-war period was the sense maintained during the Empire among Germans that their nation was, or would soon again attain the standing to be, the clear leader in bringing about the history of science's institutional development.

At the 1929 History of Science Congress, a motion by the Briton R. T. Gunther was passed that it was desirable to collect from scientists "documents, models, instruments and scientific installations…that are important to illustrate the development of science or of technology."[108] At the second conference, in 1931, the librarian and historian of chemistry Hélène Metzger indicated that collections of the portraits of historians of science, of the commemorative medals of scientists, of the autographs of scientists, and of documents such as reproductions of portraits and monuments of scientists had been started.[109] Also, the Italian historian of mathematics Gino Loria, as the president of a commission on scientific instruments which had been formed previously by the International Committee of the History of Sciences, suggested "a referendum on the opportunity and the means to conserve the instruments of selected scientists after their

[107] Scriba, "The Beginnings of the International Congresses of the History of Science," 7. Vom Brocke, "Das Elend Der Wissenschaftsgeschichte in Deutschland -- Zur Entwicklung Der Wissenschaftsgeschichte Seit Ranke, Insbesondere Im 20. Jahrhundert," 11.

[108] Anonymous, "Comptes Rendus De La Première Session Du Comité International D'histoire Des Sciences Et De Premier Congrès International D'histoire Des Sciences (Paris, 20-24 Mai 1929)," *Archeion* 11 Supplementary number (1929): lii.

[109] "Comite International D'histoire Des Sciences," *Archeion, archivio di storia della scienza* 13 (1931): 348.

death. Too often these instruments are dispersed or destroyed. The same is true of manuscripts."110 So, beginning roughly a decade after the dislocation of the First World War had ended, interest in the material culture of science again made headway at an international level; but it was during the German Empire, display at historical scientific exhibitions had first brought this interest to the fore.

The uptake of the history of science including medicine and of mathematics first at a number of congresses not exclusively devoted to their histories reflects progressive early institutionalization of the history of science at an international level. As related, a secure, ongoing international platform for the history of science discipline nevertheless was not to take hold permanently until well after the end of the First World War. One important aspect of this attainment of disciplinary security was the provision of professorships, a milestone very irregularly reached by the end of the First World War.

Other areas of the German Empire scholarly activity in the history of science were monographs and editing projects, fulfilling another of the criteria for (proto-) institutionalization. In the late nineteenth century German historical commissions introduced a more scholarly cast to historical pursuits than was characteristic of the work produced by German historical societies. Representative of the activity of the historical commissions were the published results of a project under the auspices of the Historical Commission of the Bavarian Academy of Sciences. For this project, German experts in various branches of knowledge wrote histories of them. As part of its activities, extensive histories of a number of scientific fields were written, twelve in all, between 1864 and 1918, seven in the 1870s. As with other scholarship, this project extended the group of people who had access to the history of science and contributed to forming a network for it. It also helps demonstrate that Germans were fulfilling another of the criteria for

[110] Ibid.

(proto-) institutionalization of the field, the widest range of activities associated with the history of science.

To the works sponsored by the Historical Commission of the Bavarian Academy of Sciences above might be added other German Empire works covering a full science or sub-science, one on the history of technology in the prior century by the famed teacher of technologists at the technical college in Hannover, Karl Karmarsch, published in 1872, a second a collection of lectures on the history of technical mechanics, given by professor Moritz Rühlmann at the same institution (from 1879 a Technische Hochschule), published in 1885, and various works on history of meteorology by Gustav Hellmann (who made important contributions also after World War I.)[111] Other German scientists who wrote works in the history of science during the German Empire were Siegmund Günther, Emil du Bois-Reymond, Wilhelm Ostwald, Georg Kahlbaum, Ernst von Meyer, and Edmund von Lippmann, the first a mathematician/geographer, the second a physiologist, and the others chemists. Of the six, Günther was the most personally prolific in his historical writings: a latter-day polymath, he contributed histories on the organic sciences, the inorganic sciences, the age of geographical discovery, and the mathematics of antiquity, among numerous others. Ostwald wrote on the uses of history to scientists, on the history of electrochemistry, and on the lives of individual chemists. Kahlbaum produced a biography of the chemist Christian Schönbein and a history of the German reception of the ideas of the revolutionary French chemist Lavoisier. Von Meyer supplied a history of chemistry from the earliest times as well as some celebratory pieces on past chemists

[111] Kurt Mauel, "Die Aufnahme Naturwissenschaftlicher Erkenntnisse Und Methoden Durch Die Ingenieure Im 19. Jahrhundert," in *Naturwissenschaft, Technik Und Wirtschaft Im 19. Jahrhundert : Acht Gespräche Der Georg-Agricola-Gesellschaft Zur Förderung Der Geschichte Der Naturwissenschaften Und Der Technik. Teil 1.*, ed. Wilhelm Treue and Kurt Mauel (Göttingen: Vandenhoeck und Ruprecht, 1976), 338. James R. Fleming and Simone L. Kaplan, "Historical Writing on Meteorology: An Annotated Bibliography," in *Historical Essays on Meteorology, 1919-1995: The Diamond Anniversary History Volume of the American Meteorological Society*, ed. James R. Fleming (Boston: American Meteorological Society, 1996), 557.

of note. Dubois-Reymond penned important essays on the history of sciences and on science and cultural history and published historical accounts of several scientists' lives. Lippmann was the exception in not being a university professor but rather a practicing industrial chemist in the sugar industry, and wrote essays and a couple of full-length books primarily on the history of chemistry (including on the history of development of the production of sugar and glass, and on chemical knowledge in antiquity).

Germans even before formation of the Empire became involved in editing projects of the works of some of their culture's most esteemed deceased scientists. The project to publish Johannes Kepler's collected works began in 1858, running through 1871, with eight volumes. In 1860 a project began to publish the collected works of Gauss, which had reached ten volumes (though not yet completed) through the end of the First World War. In 1899 German and British editors led an association formed from the representatives of seventeen academies in collating the works and letters of Leibniz (the first publication did not appear, however, until 1923.) In 1911 commenced the publication in Germany of the collected works of the Swiss-German mathematician Leonhard Euler.[112] The history of sciences in German lands in the second half of the nineteenth century also appeared in biographies, obituaries and as the subject of speeches at university anniversaries and other events. Some of these treatments were scholarly.

During the period of the German Empire, there were numerous investigations of particular instruments and instrument-makers, some appearing as journal articles, others as stand-alone works. As did contemporary German scientific instruments, old German instruments vouched for the Germans being a people of intelligence, perseverance and hard work, of ability to design and execute, and of adept use of materials. For some in the late nineteenth century,

[112] Kaiser-Wilhelm-Dank and Verein-der-Soldatenfreunde, *Deutschland Als Weltmacht: Vierzig Jahre Deutsches Reich, Unter Mitarbeit Einer Grossen Anzahl Berufener Deutscher Gelehrter, Offiziere Und Fachmänner* (Berlin: Wohlfahrtsgesellschaft, 1911), 456.

instruments were becoming valued for what they could show to scholars, and display organizers, about the course of the development of scientific ideas and instrumental technique. Fortifying the impression that old scientific instruments now were receiving more consideration in the German lands, there was a good amount of research on *instruments* among nineteenth and early twentieth century German works of scholarship in the history of science. A prime example of not only the new German Empire emphasis on the display of scientific instruments, but also their exploitation for scholarship, was Walther von Dyck's use of the Georg von Reichenbach instruments held by the Deutsches Museum, along with documents pertaining to Reichenbach's work in the museum's archives, in composing his deeply-researched biography of Reichenbach, issued in 1912 as a house publication of the museum.[113]

Further examples of the German Empire writing on instruments are extensive. The sugar industry chemist Edmund von Lippman considered the history of the thermometer, of the vacuum apparatus, of the water bath, of the autoclave, and of the optical polarization apparatus (used in sugar refining).[114] The nautical school director and self-trained historian of nautical apparatus Arthur Breusing explored the history of the compass, of the Jacob's staff (used in navigation), and of the sighting devices the nonius and the vernier, and for the 69th meeting of German Scientists and Physician he wrote a booklet, *Nautical Instruments up to the introduction of the Mirror Sextant.*[115] The historian of physics Ferdinand Rosenberger directed attention to the

[113] Walther Dyck, *Georg Von Reichenbach: Lebensbeschreibungen Und Urkunden* (Munich: Deutsches Museum, 1912).
[114] Edmund Oskar von Lippmann, *Abhandlungen Und Vorträge Zur Geschichte Der Naturwissenschaften*, 2 vols., vol. 1 (Leipzig: Veit, 1906). Edmund O. von Lippmann, *Abhandlungen Und Vorträge Zur Geschichte Der Naturwissenschaften*, 2 vols., vol. 2 (Leipzig: Veit, 1913).
[115] Arthur Breusing, "Zur Geschichte Der Geographie 1. Flavio Gioja Und Der Schiffskompass," *Zeitschrift der Gesellschaft für Erdkunde zu Berlin* 4, no. 1 (1869): 31-51. "Zur Geschichte Der Geographie 2. Regiomontanus, Martin Behaim Und Der Jakobsstab 3. Die Catena a Poppa Bei Pigafetta Und Die Logge," *Zeitschrift der Gesellschaft für Erdkunde zu Berlin* 4 (1869): 97-115; "Nonius Oder Vernier?," *Astronomische Nachrichten* 96, no. 9 (1879): 129-34. *Die Nautischen Instrumente Bis Zur Erfindung Des Spiegelsextanten* (Bremen: Silomon, 1890).

history of the electric machine.[116] The ship's captain Albert Schück composed material on the history of compasses and the horometer (for computing time from position of heavenly bodies and for deducing latitude) and on astronomical instruments including the Jacob's staff.[117] The mathematician Friedrich W. Barfuss and the art historian Ernst von Basserman-Jordan separately wrote on the history of clock making.[118] The mathematics professor Karl Alhard von Drach treated the spherical clock of Wilhelm IV of Kassel.[119]

The electrochemical engineer Emil Wohlwill gave a history of thermometers.[120] The historian of pharmacy Hermann Schelenz treated the history of distillation apparatus and the physicist Eilhard Wiedemann investigated clocks in Islamic culture, apparatus of Arabic chemical science, and Archimedes's clock.[121] Pedagogue Bernhard Schwalbe gave an account of the history of the steam engine, posthumously transcribed, as did engineer Conrad Matschoss in 1901 and in a second work in 1908.[122] Technologist Theodor Beck reviewed the history of

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[116] Ferdinand Rosenberger, "Die Erste Entwicklung Der Elektrisirmaschine," *Abhandlungen zur Geschichte der Mathematik* 34, no. 8 (1890): 69-88.
[117] Albert Schück, *Alte Schiffskompasse Und Kompassteile Im Besitz Hamburger Staatsanstalten* (Hamburg: J. Heinrich Luhrs, 1910). "Das Horometer, Ein Älteres Instrument Der Mathematischen Geographie," *Mitteilungen der Geographischen Gesellschaft in München* 1, no. 2 (1904/1906): 269-83. Albert Schück, "Der Jakobsstab," *Jahresbericht der Geographischen Gesellschaft München für 1894/1895* 16 (1896): 93-174.
[118] Friedrich Wilhelm Barfuss, *Geschichte Der Uhrmacherkunst Von Den Ältesten Zeiten Bis Auf Unsere Tage* (Weimar: B. F. Voigt, 1837). Ernst von Bassermann-Jordan, *Die Geschichte Der Räderuhr: Unter Besonderer Berücksichtigung Der Uhren Des Bayerischen Nationalmuseums* (Frankfurt am Main: H. Keller, 1905).
[119] C. Alhard von Drach, *Die Zu Marburg Im Mathematisch-Physikalischen Institut Befindliche Globusuhr Wilhelms Iv. Von Hessen Als Kunstwerk Und Astronomisches Instrument Beschrieben Und Besprochen* (Marburg: Elwert, 1894).
[120] Emil Wohlwill, "Neue Beiträge Zur Geschichte Des Thermometers," *Mitteilungen zur Geschichte der Medizin und der Naturwissenschaften* 1, no. 1-4 (1902): 5-8, 57-62, 143-58, 282-90.
[121] Eilhard Wiedemann and Fritz Hauser, *Über Die Uhren Im Bereich Des Islamischen Kultur*, Abhandlungen Der Kaiserlichen Leopoldinisch-Carolinischen Deutschen Akademie Der Naturforscher (Halle: Ehrhardt Karras, 1915). Eilhard Wiedemann, "Über Chemische Apparate Bei Den Arabern," in *Beiträge Aus Der Geschichte Der Chemie Dem Gedächtnis Von Georg Kahlbaum*, ed. Paul Diergart (Leipzig: Deuticke, 1909), 241-44. Eilhard Wiedemann and Fritz Hauser, "Uhr Des Archimedes Und Zwei Andere Vorrichtungen," *Nova acta - Kaiserlich Leopoldinisch-Carolinische Deutsche Akademie der Naturforscher* 103, no. 2 (1918): 165-202.
[122] H. Bohn, "Schwalbes Versuche Zur Geshichte Der Dampfmaschine," *Zeitschrift fur den physikalischen and chemischen Unterricht* 14 (1901): 203-06. Conrad Matschoss, *Geschichte Der Dampfmaschine: Ihre Kulturelle Bedeutung, Technische Entwicklung Und Ihre Grossen Männer* (Berlin: J Springer, 1901). *Die Entwicklung Der Dampfmaschine: Eine Geschichte Der Ortsfesten Dampfmaschine Und Der Lokomobile, Der Schiffsmaschine Und Lokomotive*, 2 vols. (Berlin: J Springer, 1908).

machine construction.[123] The mathematical historian Maximilian Curtze covered the essays of the medieval Jewish scholar Levi ben Gerson on the Jacob's staff, and also looked into the medieval astronomical darkroom.[124] The astronomer Wilhelm Foerster inquired into the history of the division of the circle for astronomical measurements.[125] The chemist Max Speter addressed the cooling apparatuses of Antoine Lavoisier and Justus von Liebig, the chemist Georg Kahlbaum the early history of spectral analysis.[126] The physicist Ernst Gerland considered a number of instruments including Huyghens' pendulum clock.[127]

The mathematician and geographer Siegmund Günther wrote on the *baculus geometricus* (an astronomical and geodetical apparatus for measuring angles) and on the Jacobs staff, on the pendulum clock of Huyghens and the pendulum experiment of Foucault, and on the globes of Philipp Apian.[128] Günther also delivered a talk on the Jacob's staff at the Rome International Historical Congress in 1903.[129] The Kassel official August Cöster highlighted the great astronomical clock made for Wilhelm IV of Hesse-Kassel.[130] There were even long-running

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[123] Theodor Beck, *Beiträge Zur Geschichte Des Maschinenbaues* (Berlin: J. Springer, 1899).
[124] Maximilian Curtze, "Die Abhandlungen Des Levi Ben Gerson Über Trigonometrie Und Den Jacobstab," *Bibliotheca Mathematica* 12 (1898); "Die Vorgeschichte Der Dunkelkammer," *Himmel und Erde* 13 (1901).
[125] Wilhelm Foerster, "Zur Entwickelungsgeschichte Der Zeitmessung Und Der Kreiseinteilung," *Himmel und Erde* 19 (1907): 145-57.
[126] Max Speter, "Lavoisier Und Der Gegenstromprinzip- Kühlapparat," *Chemische Zeitung* 32 (1908): 654; "Geschichte Der Erfindung Des Liebig'schen Kühlappartes," *Chemische Zeitung* 32 (1908): 3-5. Georg Kahlbaum, *Aus Der Vorgeschichte Der Spectralanalyse: Vortrag, Gehalten in Der Aula Des Museums Zu Basel* (Basel: Schwabe, 1888).
[127] for example: Ernst Gerland, "Zur Geschichte Des Thermometers," *Zeitschrift für Instrumentkunde* 13, no. 9 (1893): 340-43; "Das Sogenannte Dampfschiff Papins " *Zeitschrift für Verein hessischer Geschichte* N.F. VIII (1880): 221-27; "Christian Huygens' Früheste Luftpumpe," *Zeitschrift für den physikalischen and chemischen Unterricht* 5 (1891): 39-43; "Die Erfindung Der Pendeluhr," *Zeitschrift für Instrumentkunde* 8, no. 3 (1888): 77-83.
[128] Siegmund Günther, "Die Erfindung Des "Baculus Geometricus"," *Bibliotheca Mathematica* (1885): 137-40; "Die Erste Anwendung Des Jakobsstabes Zur Geographischen Ortsbestimmung," *Bibliotheca Mathematica* (1890): 73-80. "Ueber Die Geschichte Der Pendeluhr Vor Huyghens," *Sitzungsberichte der Physikalisch-Medizinischen Sozietät zu Erlangen* 6 (1874): 12-27.; "Ueber Die Vorgeschichte Des Foucault'schen Pendelversuchs," *Sitzungsberichte der Physikalisch-Medizinischen Sozietät zu Erlangen* 6 (1874): 52-68. "Die Münchner Globen Philipp Apians," *Jahrbuch für Münchener Geschichte* 2 (1888): 131-48.
[129] "Storia Della Scienze Fisiche, Matematiche, Naturali E Mediche (Atti Della Sezione Viii) Volume 12," xvi.
[130] August Cöster, "Über Die Große Astronomische Kunstuhr in Dem Kasseler Museum," *Zeitschrift des Vereins fur hessische Geschichte und Landeskunde Neue Folge* 5 (1874).

contestations among instrument historians, such as that between Albert Schück, Arthur Breusing and Walther Vogel on the origin of the magnetic compass.[131]

Finally, Max Engelmann, the curator of the Dresden scientific collection, from 1913 produced articles in the Communications of the Saxon Art Collections, which included the mathematical-physical Salon. Some of Engelmann's articles covered individual instrument-makers, and others, the types of instruments represented in the collections.[132] And in 1914, the instrument maker Johann Repsold published a two-volume work titled Zur Geschichte der astronomischen Meßwerkzeuge 1) Von Purbach bis Reichenbach 1450 – 1830; 2)Von 1830 bis um 1900 (On the history of astronomical measuring instruments 1) from Purbach to Reichenbach 2) from 1450 to 1830.)[133]

Another example of the Germans being first in an activity relating to the history of science was the first international inventory of scientific relics. In 1882 Ernst Gerland provided a partial inventory of the historical scientific apparatus held in a sizable number of collections, museums, or institutes in Germany and other parts of Europe.[134] Gerland's inventory helps to demonstrate the superior range of the German activity in the history of science, one of the criteria given in the introduction for its (proto-)institutionalization. Gerland's preliminary inventory on a wide scale was far ahead of its time: it was a forerunner of the national

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[131] Peter Sandmeyer, "Kompasse: Ein Wegweisende Erfindung 2. Teil: Einen "Sonnenkompass" Benutzten Schon Die Wikinger," *Der Spiegel Online Wissenschaft* (2008), http://www.spiegel.de/wissenschaft/mensch/kompasse-eine-wegweisende-erfindung-a-585768-2.html.

[132] Max Engelmann, "Die Habermelschen Instrumente in Dresden," *Mitteilungen aus den sächsischen Kunstsammlungen* 4 (1913): 41-51; "Mathematische Instrumente Von Wenzel Jamnitzer," *Mitteilungen aus den sächsischen Kunstsammlungen* 5 (1914): 44-54; "Optische Instrumente Im Mathematischen Salon Zu Dresden," *Mitteilungen aus den sächsischen Kunstsammlungen* 7 (1916): 44-65.

[133] Johann Adolf Repsold, *Zur Geschichte Der Astronomischen Messwerkzeuge: Von Purbach Bis Reichenbach 1450 - 1830*, 2 vols., vol. 1 (Leipzig: Engelmann, 1908). *Zur Geschichte Der Astronomischen Meßwerkzeuge: Von 1830 Bis Um 1900*, 2 vols., vol. 2 (Leipzig: Engelmann, 1914).

[134] Gerland, "Beiträge Zur Geschichte Der Physik: Versuch Eines Verzeichnisses Der Bis Auf Unsere Zeit Erhaltenen Originalapparate."

inventories conducted under the auspices of the International Union of History and Philosophy of Science (IUHPS) Scientific Instrument Commission beginning in 1952.

If Germans had continued uninterrupted past 1918 to foster the history of science, it is my view that we might have had at a considerably earlier time the national inventorying of scientific apparatus which the Scientific Instruments Commission eventually began pursuing in the 1950s. And it is fairly probable, in my view, that had Germany not lost a major war in 1918, it would have seen a far earlier mature development of the field of instrument studies than that acknowledged or regretted by a number of people surveying the field in the 1990s.[135]

The German scholarly striving after a deeper connection to the scientific past was mirrored by, and related to, the mounting of historical scientific displays. There was a temporal and a topical relationship between the German history of science scholarly research and displays of history of science. Sometimes the linkage was even more direct. Display organizers/advisors who were also scholars of history of science and technology included Siegmund Günther, Ernst Gerland, Hermann Peters, Karl von Sudhoff, Conrad Matschoss and Walther von Dyck, all further mentioned below. Common to these organizers is that they also conducted scholarship either on specific instruments, or on a class of instruments (for example, Peters on typical pharmaceutical utensils of different centuries, and Sudhoff on dental instruments of different civilizations).

SCIENTIFIC MEMORIALS

About the turn of the eighteenth to the nineteenth century, memorials to honor individual scientists commenced. The memorials to scientists were conceived as lending glory to German

[135] Meinel, "Vorwart," 10; Klaus Hentschel, "Historiographische Anmerkungen Zum Verhaltnis Von Experiment, Instrumentation Und Theorie," in *Instrumente -- Experimente: Historische Studien*, ed. Christoph Meinel (Berlin: Verlag für Geschichte der Naturwissenschaften und der Technik, 2000), 13; Paolo Brenni, "Historische Instrumente Als Materielle Zeugen Der Wissenschaftsgeschichte," in *Instrument -- Experiment: Historische Studien*, ed. Christoph Meinel (Berlin: Verlag für Geschichte der Naturwissenschaften und der Technik, 2000), 76.

culture. The gains that the resort to its past science brought to Germany led to the creation of memorials and naming of buildings to honor individual scientists.[136] The German lands' historical orientation and their increasing recognition of the overall importance of science in the nineteenth century led their scientific proponents to raise both past and near-contemporary scientific figures to popular recognition, and sometimes to adulation, through memorials. Science and technology were, along with statecraft and military prowess, a part of the German people's past that could be mined for deeds and personalities suitable for an embodiment in a public display.

It was only starting around 1800 that the stature of *scientists* was viewed as being sufficient to be recognized in this most public way previously reserved for statesmen and military figures. To begin with, in 1790 a Leibniz temple in Hannover honored the mathematician and philosopher Gottfried Wilhelm Leibniz (the university and the city subsequently erected additional Leibniz statues, in 1846 and 1883 respectively.) A relief of the physicist Benjamin Thomson, Count Rumford, whose work in physical theory helped to set the stage for the later development of thermodynamics, was installed during Thomson's lifetime in Munich in 1796. Just at the turn into the nineteenth century, the philosopher and scientist Immanuel Kant was "memorialized" in the last decade of his life already by several busts.

Prior to the memorializing of German scientists during the Empire, there were already decades of nineteenth-century German scientific memorial activity; in these earlier decades, this memorial activity was a source of dynastic pride or was associated with an empowered, self-assertive bourgeoisie pointing to a local initiative. Indeed, Rudy Koshar, the author of a work on

[136] Facts on a number of scientific memorials were researched through search engines inputting various scientists' names. Some have been obtained in biographies, others were derived from Wikipedia, "Liste Von Denkmälern Von Mathematikern, Naturwissenschaftlern, Medizinern Und Technikern," https://de.wikipedia.org/wiki/Liste_von_Denkm%C3%A4lern_von_Mathematikern,_Naturwissenschaftlern,_Medizinern_und_Technikern

German national memory, locates the center of the nineteenth century memorial building in various countries with "a bourgeois public".[137] The German ethnic pride, even before 1871, also undoubtedly played the principal role in the public support for memorials of different kinds, including those honoring scientists.

In the nineteenth century, there were various examples of far earlier scientists being enshrined. Along with an 1807 Copernicus memorial, for example, Kepler was honored with a memorial in Regensburg in 1808, some hundred eighty years after his death; Mainz and Frankfurt honored the fifteenth century figure Johannes Gutenberg with statues before the mid-nineteenth century. Then in 1853 a Copernicus memorial was raised in Thorn, birthplace of the cosmographer, and from 1793 a part of Prussia. The striking production of three major memorials in German lands for Copernicus spanning the period 1840-1925—one in 1840 at the Walhalla monument, the Thorn memorial, and one in 1925 at the Deutsches Museum—may find its explanation in the German efforts to push their side in the dispute over his nationality as well as in Copernicus's renown as the first "modern" scientist. In 1870, statues of the instrument maker Jost Bürgi, the astronomer and teacher of Kepler Michael Maestlin, the cosmologist Nicolaus Copernicus, and the Danish astronomer Tycho Brahe, who had spent time in the German dynastic residence city of Kassel, were included in insets of the pedestal of a new memorial to Kepler in the Württembergian town of Weil der Stadt.

Most scientists honored with sculptural treatment during the nineteenth century, however, were figures of that same century, in other words, of the recent past. For example, a subscription drive was launched in the late 1820s by the publisher of the music journal *Iris*, calling on the people of Breslau and its province Silesia to contribute to a memorial to be installed at the

[137] Rudy Koshar, *From Monuments to Traces: Artifacts of German Memory, 1870-1990* (Berkeley: University of California Press, 2000), 30.

common grave site of two figures who had been important in the contemporary life of the city and the province—one of whom was the physicist Ernst Chladni who had died in 1827.[138] Memorials were created for the early nineteenth century instrument makers Georg von Reichenbach and Josef von Fraunhofer, installed at the Bavarian Hall of Fame which opened in 1853. Lorenz Oken, the naturalist famed for his origination of the German Natural Scientists and Physicians meetings, was celebrated with a memorial at Jena in 1857. At Berlin University, Albrecht Thaer, "father of German agronomy", received the same recognition in 1859. 1867 again saw the placement of a memorial in Munich to Count Rumford.

Far more monuments to scientists were constructed during the time of the German Empire, which in general was known for its (sometimes excessive) monument-building, extending to more than a thousand, than even in the preceding decades.[139] One can attribute this tendency as a whole to the newness of the nation, anxious to emphasize its *gravitas* and to create symbols to unite its people.[140] The enhanced profile of its scientific heroes as *national* heroes in the nineteenth century led not only to a much greater preservation of their scientific relics but to the memorials heralding them.[141] The example of the Berlin Potsdamer bridge statue of Wilhelm Röntgen created while he was still alive in 1898 not long after announcement of his discovery of X-rays was a rarity, but it underlines the point that those scientists who were in living memory were the ones most likely to be recognized with a monument during the German Empire. This attention to recent scientific historical figures by the majority of the German Empire memorializing differed from that featured in historical scientific displays, many of which

[138] Anonymous, "Chladni's Und Berner's Denkmal," *Eutonia, eine hauptsächlich pädagogische Musik-Zeitschrift* 1 (1829): 202. "Chladni's Und Berner's Denkmal," *Iris im Gebiete der Tonkunst* 2 (1831): 12.
[139] Koshar, *From Monuments to Traces: Artifacts of German Memory, 1870-1990*, 31.
[140] Ibid., chapter 1.
[141] Anthony Turner, "From Mathematical Practice to the History of Science: The Pattern of Collecting Scientific Instruments," *Journal of the History of Collections* 7, no. 2 (1995): 145-46.

featured artifacts from science's distant past. Recognition of German scientists in the form of memorials was sometimes undertaken by public subscription, giving us a sense of the importance of science in the nineteenth century but also, perhaps, of the attempt to assert the cultural credentials of science in a period when this was contested.

Liebig was the subject of one outdoor memorial in 1883 in Munich, a second in 1890 in Giessen, and another in 1913 in Darmstadt.[142] Other German chemists of the recent past for whom statues or busts were erected during the German Empire included Eilhard Mitscherlich, Liebig's collaborator Friedrich Wöhler, Robert Bunsen, Carl Fresenius, August Kekulé, Adolf von Baeyer, Rudolf Christian Böttger, Victor Meyer, and from a slightly earlier period, Andreas Marggraf, and Franz Karl Achard.[143] A marble bust of A. W. Hofmann was produced even while he was still living.[144] Besides chemists, physicists were the most frequent object of veneration through memorials during the German Empire. Of physicists, monuments were created for Otto von Guericke of the seventeenth century, and for the nineteenth century physicists Georg Simon Ohm, Carl von Steinheil, Hermann von Helmholtz, Wilhelm Röntgen and for Wilhelm Weber and Carl Gauss together. Gauss had his own memorial in Braunschweig.

There was some recognition during the Empire of other earlier scientists: examples include the monuments for the thirteenth century exponent of science Albertus Magnus, which came out of the foundry of Ferdinand Miller in 1870, for the fifteenth century mathematician Johannes Müller von Königsberg, also known as Regiomontanus, completed in Königsberg in 1871, and for the seventeenth century natural philosopher Leibniz, dedicated in Leipzig in 1883

[142] Volhard and Fischer, *August Wilhelm Von Hofmann: Ein Lebensbild Im Auftrage Der Deutschen Chemischen Gesellschaft*, 127.
[143] Ibid., 140 testified that the monuments for Marggraf and Achard were busts installed in the (August Wilhelm) Hofmann-Haus, the new residence of the German Chemical Society, in Berlin in 1900, eight years after Hofmann's death.
[144] Ibid., 173.

and mentioned above, and for the fifteenth century geographer Martin Behaim, raised in Nuremberg in 1890. A memorial for Johannes Gutenberg, this time at Magdeburg, in 1901 joined those at Mainz (the city where Gutenberg was born and to which he had returned from Strassburg when he executed the printing of his Bible) and Frankfurt and the 1840 statue to him in Strassburg (the city where he first demonstrated printing) acquired in 1871 when Alsace-Lorraine was annexed by the Germans after their victory in the Franco-Prussian War.

Others for whom German Empire memorials appeared were made up in the main by nineteenth century figures. These included the geographers Leopold von Buch and Alexander von Humboldt, the physiologists Johannes Müller and Theodor Schwann, the anatomist (and inventor of the first electrochemical telegraph) Samuel Thomas von Soemmerring, the botanist Matthias Jakob Schleiden, the physician and originator of the conservation of energy law Robert Mayer, the biologist Ernst Haeckel, the microbiologist Robert Koch, the inventor of the steam press Friedrich Koenig, "the inventor of the telephone" (as styled at some German displays) Philipp Reis, the veterinarian Andreas Gerlach, and several for the engineer/inventor Werner von Siemens. Astronomer Friedrich Magnus Schwerd was honored in Speyer in 1874 with a bust by famed monumental sculptor Ferdinand Miller. Mathematician and astronomer Friedrich Wilhelm Bessel received a memorial at the Königsberg Observatory in 1882.

A marble bust of celebrated pathologist Rudolf Virchow went up in front of the Charité university clinic in Berlin in 1882, twenty years before his death. 1896 saw the installation in Munich of a memorial for Franz von Kobell, known in mineralogy, as well as of a statue of the still-living polar researcher Georg Neumayer in Hamburg. A statue of a Titan overmastering the Sphinx constructed in 1910 memorialized the now deceased Virchow in Berlin. An Ernst-Abbe-Temple for the famed optical scientist was built from 1908-1911.

Of course, tangible memorializing of scientists could also, on a less grand scale, take place through painted portraiture. This, unlike most statuary, was sometimes executed during the sitter's lifetime. So, for example, the King of Prussia commissioned in 1886 a painting of the physicist Franz Ernst Neumann, an aging hero of the German anti-Napoleonic forces, for the National Gallery in Berlin, while the following year the Minister of Education commissioned another portrait of Neumann to be hung in Berlin University.[145]

Of all the foregoing, for whom German Empire monuments were created, only Albertus Magnus, Regiomontanus, Gutenberg, Behaim, Guericke, Leibniz, Papin, and Marggraf were not active, in part or wholly, during the nineteenth century, and of these, more than half preceded the seventeenth century. A greater focus on memorializing scientists of the *nineteenth* century may be explained to some extent by the downturn in German science (although with major exceptions) in the prior two centuries.

The impulse to remember scientists, physicians, and technologists in this way during the German Empire was widely scattered. Their nineteenth century memorials looked out at locals and visitors in a wide variety of German sites. The memorials to scientists sprang up in Berlin, Giessen, Jena, Hamburg, Nuremberg, Leipzig, Heilbronn, Munich, Heidelberg, Göttingen, Frankfurt, Stuttgart, Bonn, Königsberg, Wiesbaden, Thorn, Koblenz, Magdeburg, Regensburg, Eisleben, Neuss, and Lauingen. In words that Rudy Koshar has used to describe German Empire national monuments, we also can locate that period's scientific memorials: they were "scattered throughout the political landscape to emphasize not only national unity but also the diversity of the provinces' participation in the larger collectivity."[146]

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[145] Robert Knott, "Neumann, Franz Ernst," in *Allgemeine Deutsche Biographie*, ed. Historischen Kommission bei der Bayerischen Akademie der Wissenschaften (Leipzig: Duncker & Humblot, 1906), 680-84.
[146] Koshar, *From Monuments to Traces: Artifacts of German Memory, 1870-1990*, 33.

This self-definition of German provinces through memorials during the Empire was partially achieved on the basis of subscriptions begun by bourgeois individuals and solicited mainly among the bourgeoisie, to the honor of the fellow members of the bourgeoisie. Several examples will provide a flavor for this undertaking: his fellow-chemist Jacob Volhard gives an account of solicitations by August Wilhelm von Hofmann (raised to the nobility in 1888 but of bourgeois origins) for two memorials for Liebig (1879 and 1890; Liebig, although raised to the nobility in 1845 by his Bavarian king, was likewise of bourgeois origins) and one for Friedrich Wöhler (1890).[147] Donations were sent to Oranienburg by the German Chemical Society (nearly exclusively bourgeois in membership judging from its founding year *Bericht* [Report]) in 1872 to fund a memorial to the analytical chemist Friedlieb Ferdinand Runge at his gravesite in the town where he had done his life's work.[148] Also illustrative of bourgeois civic projects were memorials initiated by chemist Victor Meyer for fellow chemists Friedrich Wöhler (deceased) and Hofmann (in celebration of his 70th birthday) and a painting of the aged (79 years) chemist Robert Bunsen.[149]

German memorials to scientists were an indicator of nineteenth century interest in and awareness of history of science. The fact that the Empire period saw an increase in such memorialization is consistent with my claim that there was a spike then in such interest and awareness generally. The local and the sometimes far-flung bourgeois-led projects to commission and install statuary in honor of such a group of German scientists may well have sparked an interest among some other Germans to visit an exhibition featuring the history of

[147] Volhard and Fischer, *August Wilhelm Von Hofmann: Ein Lebensbild Im Auftrage Der Deutschen Chemischen Gesellschaft*, 127.
[148] Gaby Huch, "Der Entdecker Des Anilins Starb Relativ Unbekannt: Friedlieb Ferdinand Runge -- Oranienburger "Professorenklexe"," Berliner Zeitung, http://www.berliner-zeitung.de/der-entdecker-des-anilins-starb-relativ-unbekannt--friedlieb-ferdinand-runge-oranienburger--professorenklexe--17279114.
[149] Meyer, *Victor Meyer: Leben Und Wirken Eines Deutschen Chemikers Und Naturforschers, 1848-1897*, 192.

science. As one component of the extensive range of activities related to the history of science during the German Empire, they help substantiate the claim I make in the introduction that it was the Germans above all others who spurred the (proto-)institutionalization of the history of science.

OTHER GERMAN ACTIVITY IN THE HISTORY OF SCIENCE

Other signs of a budding German interest and activity in the history of science were diverse and exemplify the wide range of the German activity in the history of science and its continuous sustaining of that activity in various forms during the whole of the Empire, thus forming the earliest developments in what has been the ongoing build-up of the field of the history of science since the 1870s.

Journals of the institutionally-based science sites like the Berlin Urania (a site with hands-on exhibits of scientific materials, but not historically presented) and the Treptower Sternwarte (Observatory), under the editorships of Max Wilhelm Meyer and Friedrich Simon Archenhold respectively, included some features on historical topics. Scientist-professors offered university lecture courses on the history of their particular sciences such as Hermann Kopp's on chemistry, Johann Poggendorff's on physics, Wilhelm Foerster's on astronomy, and Felix Klein's on mathematics. In 1868 Poggendorff published a massive two-volume compendium, becoming almost instantly indispensible in the field, of biographical information on the scientists of various countries and periods (two additional volumes appearing during the Empire after his death in 1877). Wilhelm Ostwald, one of the fathers of physical chemistry, launched as general editor a markedly innovative series titled *Klassiker der exacten Wissenschaften* (*Classics of Exact Sciences*), comprising reprints of fundamental scientific research publications together

with explanatory notes, beginning with the first in 1889, and issued by several publishers through well over a century, with volume 304 appearing in 2010 and reissued in 2013.

Georg Kahlbaum from 1897-1904 edited a series of eight works, the *Monographieen aus der Geschichte der Chemie* (*Monographs from the History of Chemistry*). From 1913 a series titled *Klassiker der Naturwissenschaft und Technik* (*Classics of Natural Science and Engineering*) began, edited by German historian of technology Carl von Klinckowström and the German-educated Austrian historian of science Franz Strunz and extending for a short period after the end of World War I.

Eugen Tornow, a producer of high-quality lenses, endowed in 1897 an annual prize to be awarded to the best chemical historical work in general, or specifically about rare metals.[150] Chemist Ludwig Darmstaedter accumulated a massive collection primarily of historical scientific autograph manuscripts and diaries from the fifteenth century to 1900, by 1907 giving it to the Royal Library in Berlin. Franz Maria Feldhaus, an inventor specializing in mechanics, began in 1909 an institute researching historical natural scientific and technological achievements based around a prodigious card-catalog (and going commercial with the card-catalog in 1919). Several Germans, most notably Kahlbaum, published correspondence between renowned past chemists, among them Friedrich Wohler, Justus Liebig, Christian Schönbein, Michael Faraday, and Jon Jakob Berzelius. And A. W. von Hofmann, as perhaps Germany's most high-profile chemist in the last decades of the nineteenth century, wrote tens of lengthy obituaries of chemists, a number of them constituting full scientific biographies.

[150] Georg Kahlbaum, "Notizen Und Nachrichten," *Mitteilungen zur Geschichte der Medizin und der Naturwissenschaften* 3, no. 5 (1904): 482-83. Friedrich S. Archenhold, "Personalien," *Das Weltall -- Illustrierte Zeitschrift für Astronomie und verwandte Gebiete* 5, no. 1 (1904): 21-22 gives the endowment date as 1898.

CONCLUSION

The promising beginning made in the history of science in Germany, most unfortunately, was cut short by its defeat in the First World War. Prior to that cataclysm, we see the favorable climate for the history of science emerging. Despite the numerous manifestations of a German activity in history of science, however, the time was not yet ripe, before the outbreak of the First World War, for the secure full institutionalization of the discipline of the history of science in Germany or elsewhere. The fact is that neither in Germany, where the greatest marks of interest in the history of science were found before the First World War, nor in France, where there were also a good number of scholars in it, was there enough critical mass to fully launch the discipline. All but a couple of the first lectureships or professorships in the history of science or technology—Pierre Laffitte became a professor of history of science (as a non-expert political appointee) at the Collège de France in Paris in 1892, Conrad Matschoss a lecturer in history of technology at the Technical High School of Charlottenburg, outside Berlin, in 1909—came after the end of World War I.[151] A full flowering of institutional development in history of sciences within Germany was not yet achieved even into the mid-1920s. This certainly applies to the issue of women's representation and participation. The German Scientists and Physicians meetings, the primary comprehensive institutional entity for these groups throughout the majority of the nineteenth century, were organized by males and gave primacy to them.[152] Emphasizing this, Myles Jackson asserts that sessions of choral society (*Liedertafel*) singing of German folk songs, from 1826 one of the important glues of sociability for the Physicians and Scientists meetings, were barred to women.[153] The people involved in organizing the displays of history of science

[151] George Sarton, "Paul, Jules, and Marie Tannery (with a Note on Grégoire Wyrouboff)," *Isis* 38, no. 1/2 (1947): 35.
[152] Jackson, *Harmonious Triads: Physicists, Musicians and Instrument Makers in Nineteenth-Century Germany*, 74.
[153] Ibid., 53.

were of several descriptions: academic or practicing scientists, physicians, archivist-librarians, academic high school science teachers, or engineers. These were all exclusively or very largely male positions during this period in Germany. Thus, the world of the early history of science there was made up virtually exclusively of men, a circumstance which it shared with a great many cultural activities in Germany. Although there was an element of popularization in the initiatives developing the history of science, in Germany there was not, unlike in Britain, a strong trace of female involvement in even published science history popularization.

With the end of the First World War and of the Second Reich in 1918, blows to the international standing of Germans in history of science came with the nation's and the discipline's subjection to the postwar dislocation and then currency devaluation. Further, those Germans who continued to pursue the history of science initiatives experienced ostracism, in common with the remainder of German cultural and intellectual enterprise, from the rest of Europe and North America.[154] I maintain that it is primarily this upheaval which has led to an unjustified effacement of the German contributions to the early institutionalization of the history of science.

This had not always been true. For example, during the late German Empire there was still a purportedly widely-held American view, entertained by the historian of science F. E. Brasch among others, that the German scientists were exemplary in lending a historical dimension when teaching science, a practice the German physiologist and scientific spokesman Emil du Bois-Reymond had especially recommended.[155] Two factors, though, may have served

[154]Erdmann et al., *Toward a Global Community of Historians: The International Historical Congresses and the International Committee of Historical Sciences 1898-2000, Translated by Alan L. Nothnagle*, 105; William Coleman, *French Views of German Science* (New York: Arno Press, 1981), iii [no actual pagination]; Brigitte Schroeder-Gudehus, "Nationalism and Internationalism," in *Companion to the History of Modern Science*, ed. Robert Olby (New York: Routledge, 1990), 915. Meinel, "German History of Science Journals," 84.
[155] Arnold Thackray, "The Pre-History of an Academic Discipline: The Study of the History of Science in the United States, 1891-1941," in *Transformation and Tradition in the Sciences: Essays in Honor of I. Bernard Cohen*, ed.

to later instill a disciplinary narrative running that, until 1929, the key organizational activities had not yet occurred. First, the World War had led to the dissolution from 1914 to 1926 of the previously constituted International Committee of the History of Science. Second, the congress of the history of science in 1929 was the first international conference *devoted solely* to the history of science. The activity prior to the First World War may have come to appear to be strictly preliminary to the substantial build-up from the end of the decade of the 1920s.

As recorded above, Germany had first restored its wider scientific activity in 1926 in becoming part of an international committee for historical sciences, reconstituted post-war, for planning the 1928 international congress for *historical sciences* (not for the *history of science*) to be held in Oslo. German scholarly reintegration continued with the staging of the 1929 international history of science congress in Paris. The new leaders in completing the institutionalization of the history of science as a discipline in the recovery after the world war, though, were the United States and Britain. Significantly, the history of science journal *Isis* was started in Belgium in 1913, with articles in French, Italian, German and English. Discontinued during the war and moving to North America, publication resumed from 1919, offering a frequent (issue-by-issue and then, from 1922, annual) international bibliography of works in the history of science; having celebrated its centenary and still active today, *Isis* is famed for achieving the longest publishing run of any journal in the discipline.

Notwithstanding these later developments, a strong start in the direction of the formation of the institutions of history of science as a field took place in the late nineteenth century, and Germany became the paradigmatic engine for it. Increasingly during the middle and later nineteenth century, the enterprise of sciences was manned(!) by an extensive army, notably in

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Everett Mendelsohn (New York: Cambridge University Press, 1984), 101. Gabriel Ward Finkelstein, *Emil Du Bois-Reymond: Neuroscience, Self, and Society in Nineteenth-Century Germany* (Cambridge, Massachusetts: MIT Press, 2013), 229.

Germany. From this number, largely if not exclusively male, were drawn a select group performing inquiry into and communication of sciences' pasts.

After some decades, at the latest by sometime within the second half of the twentieth century, the earlier German leadership in formation of the field had become obscured. The narrative became shortened so that it seemed that all the important developments in it had taken place after the First World War. This has largely excluded Germans from the current story of the institutionalization of the history of science. This dissertation intimates that such an exclusion is unjustified. Germans were central to the start of the development of the field, and the narrative of this early development needs to be shifted backwards to the 1870s, the first decade of the newly unified German nation, to include the Germans in their full range of activity. As in the case of the displays, to be covered in detail in the next two chapters, the many activities specified here are a testament to the belief among the German practitioners of science, and to a degree among the general German public, that the history of science could function as an element in binding together the new nation and join with its contemporary science to provide a signature for the German character.

CHAPTER II:

REMARKS CONCERNING THE DISPLAYS AND EXHIBITION GENERALLY AND A REVIEW OF TEMPORARY DISPLAYS

After providing some remarks concerning the displays and exhibitions generally, Chapter 2 gives specifics on the *temporary* historical scientific displays mounted during the German Empire. The main points of the remarks section of the chapter are that there is a traceable history of public access to displays and collections, that exhibition culture marked particularly the second half of the nineteenth century, and that, with the German Empire's marked increase in historical scientific displays and exhibitions, there was an unevenness in their success at introducing didacticism. The chief elements of the chapter's second section regarding temporary displays were that they varied widely in size and scope, that the bourgeoisie played a leading role in the introduction of exhibition culture, and that in most cases displays of scientific relics provided an opportunity for the *general* public to access them, thus generating not only a specialist cadre of history of science enthusiasts but a more broadly-based set of interested people. The sources employed for this chapter include published display catalogues, newspaper articles, and some secondary accounts.

GENERAL REMARKS

A brief treatment of the general historical transition to display as an enlargement of the public sphere may be helpful. A somewhat expanded cadre was already visiting the Royal Saxon Mathematical-Physical Salon in Dresden with its opening in 1728. In some other European states in the eighteenth century, influenced by the ideals of the Enlightenment, state initiatives helped to lead the way to a broadened public access to organized collections, including those of

scientific instruments. The Hessian ruling house moved its scientific apparatus collection in the residence city of Kassel into the Fridericianum in 1779, and with this came in principle a general access to its collection.[156] Milestones in France and England were the openings of the art collection twice weekly in the Palais Luxembourg beginning in 1750 and of the diverse collections of Hans Sloane at the British Museum from its opening in 1759. The latter included a number of ancient mathematical instruments, which the public could examine. In 1793, the Louvre art collections became open to the public.[157]

The origins of planned technological exhibition in France for the broad public go back to the Paris Observatory. In operation since the early 1670s, this institution, under Jean-Dominque Cassini, director beginning in 1784, declared its intention to set out a collection of old instruments (some of its own, now grown old, and some others it had acquired when they were already relics) with a wide public access. The plans were disrupted during the revolutionary period and were ultimately only realized at the Observatory in the late 1870s.[158] Natural historical collections together with scientific instruments, some of them ancient, became publicly accessible at the *Imperiale e Reale Museo di Fisica e Storia Naturale* (Imperial and Royal Museum of Physics and Natural History), supported by the Grand Duke of Lorraine, from 1775 in Florence, and remained so until reconfiguration of the museum in 1807, and again were accessible there from 1829 to 1930.[159]

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[156] Turner, "From Mathematical Practice to the History of Science: The Pattern of Collecting Scientific Instruments," 143.
[157] Tatiana Sfedu, "Musemsgründung Und Bürgerliches Selbstverständnis: Die Familie Leiner Und Das Rosgartenmuseum in Konstanz" (Universität Konstanz, 2006), 18.
[158] Laurence Bobis and Suzanne Débarbat, "Instruments on Display at the Paris Observatory," in *Scientific Instruments on Display*, ed. Silke Ackermann, Richard Kremer, and Mara Miniati (Boston: Brill, 2014), 99.
[159] Anonymous, "Università Degli Studi Firenze -- Museo Di Storia Naturale -- Storia," http://www.msn.unifi.it/vp-130-storia.html.

Nineteenth century displays of contemporary technology offering collections for inspection in public space started impressively with the opening in 1800, in the wake of the French Revolution with its bourgeois egalitarianism, of the *Conservatoire des arts et métiers* in Paris in the Saint-Martin-des-Champs Abby. There, some slightly outdated instruments formed part of the collection. A proposal for the separation in 1814 of the government-owned instruments into two classes, those suitable for use in teaching and those no longer suitable but of interest in showing the progress of science, housed respectively at the Collège Royale and the *Conservatoire*, marked recognition, for one of the first times anywhere, of a distinct function for old instruments. In practice, the *Conservatoire* did not separate the two kinds of instruments, yielding to the argument that progress in science was best displayed through a continuum of past into present.[160]

The German Empire period's innovation of mounting temporary historical scientific displays and its increase in permanent historical scientific displays should be viewed within the context of exhibition culture as a whole during the second half of the nineteenth century and the start of the twentieth. Temporary displays' and museums' subjects of presentation were overlapping and together they formed a part of bourgeois culture.[161] The access to German science exhibitions by the general public, in some cases even those held by professional scientific organizations primarily for their own memberships, is part of the culture of exhibitions which the bourgeoisie launched beginning at least by the mid-nineteenth century. This culture had its most compelling origins in the shift towards public accessibility of the wide public to museums and botanical gardens associated with the French Revolution's new order, discussed by

[160] Laetitia Maison, "Les Instruments Anciens D'astronomie, Histoire Et Enjeux Actuels De Leur Mise En Exposition," *Mémoire de DEA de Muséologie des Sciences Naturelles et Humaines* (2000), http://astro-history.hautetfort.com/list/downloads_-_memoires_et_theses_en_telechargement/DEA-LaetitiaMaison.2.pdf.
[161] Martin Wörner, *Vergnügung Und Belehrung Volkskultur Auf Den Weltausstellungen 1851 - 1900* (Münster: Waxmann, 1997), 15 footnote 64.

E.C. Spary in her *Utopia's Garden*.[162] As outlined in Lynn Nyhart's *Modern Nature* and Denise Phillips's *Acolytes of Nature*, the increase in the mass press with popular publications on science, the formation of voluntary associations and lecture series for science, and the establishment of zoos then led to other ways that the wide public was able, and encouraged, to take an interest in matters of science.[163] All these trends combined with the panoply of scientific discoveries and, late in the nineteenth century, the applications of these discoveries to industry, prompted a pervasive German sense of science as a cultural and national good that drew the nation's citizens together. It was with this background that Germans during the Empire came to see displays and exhibitions of the history of science.

Museums and displays in the late nineteenth century were becoming of ever greater significance and tended to draw in an enlarged public. The movement in this direction in German lands was subsequently crowned with the publication of a journal from 1905, *Museumskunde*, and with the formation of the German Museums Association in 1917, which devoted itself to the professional administration of museums.

The exhibition mentality that grew to fruition in the nineteenth century can be seen as an important component of the bourgeois public's sense of itself. Science and technology, whose eighteenth and nineteenth century extension was largely driven by the bourgeoisie, were featured at major exhibitions beginning with the 1851 London first World's Fair, and particularly technological objects had some of the greatest appeal of all exhibition objects to visitors.[164] According to the researcher in the history of technology Michael Hascher, exhibitions "seemed

[162] E. C. Spary, *Utopia's Garden: French Natural History from Old Regime to Revolution* (Chicago: University of Chicago Press, 2000), 227, 30.
[163] Lynn K. Nyhart, *Modern Nature: The Rise of the Biological Perspective in Germany* (Chicago: University of Chicago Press, 2009), 17, 79. Phillips, *Acolytes of Nature: Defining Natural Science in Germany, 1770-1850*, 12.
[164] Bowler and Morus, *Making Modern Science: A Historical Survey*, 378.

to symbolize the confident and progressive public face of science and technology."[165] The heightened role of the science exhibitions in the late nineteenth and early twentieth century in Germany can be seen in that visits to both the Berlin Urania and the Deutsches Museum were made a feature of the school year by the school authorities in, respectively, Berlin and Munich.

As the contemporary exhibitions expert Otto Witt, director of the Institute for Technical Chemistry of the Berlin College of Technology, and president of the International Chemical Congress at Berlin in 1903, put it, making specific reference to science, "Exhibitions are a product of the heightened intensity of the intellectual work of our time, but they powerfully contribute on their part to the continually increased intensity" of that intellectual work.[166] He noted that "[t]he World's Fairs were so stimulating to all circles, that gradually a total necessity for viewing exhibitions grew up in the most diverse layers of society."[167] The penchant for exhibition-going may have involved all the social sectors beginning in this period, but the movement promoting such events stemmed from the bourgeoisie. World's fairs had a strong connection to science along multiple pathways. As Richard Bellon has noted of the first World's Fair in 1851, all facets of the planning and conduct of the fair, and even its subsequent review, drew in scientific practitioners.[168] This enhanced place of science continued at subsequent world's fairs.

An episode that illuminated the strong desire among the Germans of the Empire to exhibit themselves positively in science and technology—in the senses both of a concrete display

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[165] Michael Hascher, "Technikvermittlung Bei Der Stromsystemwahl Für Die Elektrifizierung Der Eisenbahn Im Ruhrgebiet, 1947-1955," in *Technikvermittlung Und Technikpopularisierung: Historische Und Didaktische Perspektiven*, ed. Lars Bluma, Karl Pichol, and Wolfhard Weber (Münster: Waxmann, 2004), 69.
[166] Jeffrey Allan Johnson, *The Kaiser's Chemists: Science and Modernization in Imperial Germany* (Chapel Hill: University of North Carolina Press, 1990), 52. Otto Witt, "Naturwissenschaftlich-Technische Ausstellungen," in *Die Allgemeinen Grundlagen Der Kultur Der Gegenwart*, ed. Paul Hinneberg (Berlin: Teubner, 1906), 428.
[167] Witt, "Naturwissenschaftlich-Technische Ausstellungen," 414.
[168] Richard Bellon, "Science at the Crystal Focus of the World," in *Science in the Marketplace Nineteenth-Century Sites and Experiences*, ed. Aileen Fyfe and Bernard V. Lightman (Chicago: University of Chicago Press, 2007), 306.

and as a reflection of the national stature--occurred in 1876, as Germany was participating in that year's Centennial World's Fair at Philadelphia. Franz Reuleaux, a leading German theoretical engineer, visited the Philadelphia fairgrounds, and took away a highly unfavorable opinion of the performance of the German firms who had sent products. His verdict was that the German products sent were marked by being both inexpensive and poorly made (*billig und schlecht*). With access to newspaper publication, Reuleaux set his reaction before the German public, and a furor resulted. Reuleaux was judged harshly by many fellow-Germans for his sending negative views of German manufactures into widespread circulation, but there was also a dismay that goods deserving such dismissive assessment had given a poor impression of Germany. By contrast, at most *historical* scientific displays, the German relics of science reflected well on essential Germanic traits. That is not to say that at such historical displays, objects of indifferent quality were never displayed, but that, judging by the best of what was displayed, German skill, precision, and diligent work were in evidence.

Putting historical scientific objects on display gave rise to impacts on a number of audiences. One impact was alerting the practitioners of science themselves to old research that could be suggestive for the present-day researcher. The authorities at the Deutsches Museum, and probably at some other displays such as the 1893 mathematical display at Nuremberg, conceived that previously used and discarded assembly of apparatus, "viewed in the light of the present" might yield surprising possibilities once again.[169] Karl von Sudhoff in typically convoluted prose emphasized that the Deutsches Museum's assembling of historical artifacts could be instructive to the work of the *contemporary* researcher who did not shun sifting through

[169] Anonymous, "Bericht Über Die Sechste Ausschusssitzung," 37.

them.[170] Some organizers of historical scientific displays were motivated by the suggestion that the relics of the history of various sciences were receding and that determined efforts to prevent their loss and highlight their value must occur while there was still time. Already in his 1878 report of the 1876 London exhibition's historical division, Ernst Gerland hinted at how easily scientific relics can temporarily or permanently disappear.[171] Hermann Peters at the Pharmaceutical Central Museum bade pharmacists to look over whatever they possessed in their traditional premises and deed it to the Museum. Miller at the Deutsches Museum, and his museum associate Conrad Matschoss of the Society of German Engineers, were avid conservationists. And the same impulse can be seen in Archenhold, who journeyed to Hven in Denmark to do an archaeological dig at the site of famed astronomer Tycho Brahe's observatory. Also, Sudhoff wrote of the challenge of "unearthing and getting hold of" links in the chain of technological development and of the "corrosion and mold" that medical artifacts were subject to.[172] Such initiatives to bring together objects in danger of decomposition and disappearance was accompanied by a nascent awareness that the key apparatus of *contemporary* scientific eminences should be conserved, recognizing that they would later be of an historical interest.

It was instructive for non-specialists and scientists to see the very primitive instruments by which major discoveries had sometimes been made. This point was introduced by a British representative at the 1876 London science exhibition popular talks.[173] The same point was brought out by Eugen Hartmann in the talk he gave at the Deutsches Museum when presenting

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[170] Karl von Sudhoff, "Zur Grundsteinlegung Des Deutschen Museums Von Meisterwerken Der Naturwissenschaft Und Technik Am 13. Nov. 1906," *Münchener Medizinische Wochenschrift* 53, no. 4 (1906): 2251.
[171] Ernst Gerland, "Bericht Über Den Historischen Theil Der Internationalen Ausstellung Wissenschaftlicher Apparate in London Im Jahre 1876," in *Bericht Über Die Wissenschaftlichen Apparate Auf Der Londoner Internationalen Ausstellung Im Jahre 1876*, ed. August Wilhelm Hofmann, Heinrich von Achenbach, and Adalbert von Falk (Braunschweig: F. Vieweg, 1878), 18, 36.
[172] Sudhoff, "Zur Grundsteinlegung Des Deutschen Museums Von Meisterwerken Der Naturwissenschaft Und Technik Am 13. Nov. 1906," 2254.
[173] John Tyndall, "Faraday's Apparatus," in *Free Evening Lectures Delivered in Connection with the Special Loan Collection of Scientific Apparatus.* (London: Chapman and Hall, 1876), 133.

the Frankfurt Physical Society's gift of the Soemmerring telegraph.[174] And Thomas Link, an educator who commented on the value of the Deutsches Museum for school visitors, noticed that when they saw such simple apparatus they were at first "astonished, which soon yielded to a sympathetic smile.[175] Karl von Sudhoff put it this way:

> Gradually people have realized that this neglect of development signifies under all circumstances a needless and vastly extending squandering of work, that ever and ever again by the neglect of the side paths of development countless must be re-gleaned which in the most fortunate case is brought out again by a new artful angling, but in the overwhelming majority of cases signifies lasting loss…a historical museum is the storage room of *new* [my italics] technical and natural scientific ideas.[176]

Another impact of historical scientific displays was to raise the level of awareness of science' past among the general educated public, while perhaps even elevating further the German enthusiasm for present-day science. Several of the displays in the German Empire can be said to have aimed directly at the popularization of science. If old scientific artifacts had once been, in the main, viewed as useless, the historical spirit so evident in German lands in the nineteenth century had worked a significant change in such attitudes. The display-goer benefitted sometimes from the attempt by organizers to offer materials in a *gemeinverstandlich* (easily understandable) manner involving labeling done with the average visitor in mind. Personal memorabilia, correspondence, and portraiture and other likenesses were sometimes included to give a more personal flavor to the otherwise technical objects. Here the aim was to attract and enlighten a wider circle of people to the fascination and achievements of science through easing barriers and dispelling the sense that science was a remote, elite pursuit. Yet some discrimination was important particularly at the national institutions the Germanisches Nationalmuseum and the

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[174] Max Speter, "Die Historischen Chemischen Originalapparate Des 'Deutschen Museums Von Meisterwerken Der Naturwissenschaft Und Technik' in München," *Zeitschrift für angewandte Chemie & Zentralblatt für Technische Chemie* XXI, no. 14 (1908): 625.
[175] Thomas Link, *Das Deutsche Museum Im Dienste Des Physikalischen Unterrichts* (Munich: Kellerer, 1911), 6.
[176] Sudhoff, "Zur Grundsteinlegung Des Deutschen Museums Von Meisterwerken Der Naturwissenschaft Und Technik Am 13. Nov. 1906," 2251.

Deutsches Museum. The head of the Germanisches Nationalmuseum's science division Siegmund Günther sought the "…offloading of… ballast" in those cases that such had made its way into the museum's hands. After Günther's direct involvement at the museum was long over, another Essenwein subordinate, Hans Bosch, also pointed up the selectivity that went into enlarging the museum's collections, insisting that "no piece is found [by the museum's staff] too worthless if it increases the collections' didacticism, but also no piece is too expensive—presupposing availability of funds—if it is necessary for completion of the collection" it belongs to.[177]

At the national institutions, there was the anticipation that the collections would be useful in scholarship, and this clearly propelled the administrators at each to a level of exhibition organization that was not found at a number of the temporary displays and also at the two smallest museums, the Treptower Sternwarte Museum and the Liebig Museum, treating the history of science originating during the German Empire. The Hamburg Museum for Arts and Trades and the Kaiserin-Friedrich Haus fell somewhere in between, having some of resources to support at least outside research. The head of the science division of the Germanisches Museum Siegmund Günther's recognition of the importance of giving an "order [to the display items] according to scientific principles", similar to the position of his superior Essenwein, was aligned with Günther's systematizing conception that within each class of instruments of a certain application there was a "struggle for existence" of its various types.[178]

The sources I have used do not reveal whether the displays' organizers articulated popularization as a potential hazard threatening their educative value. At least in a few instances,

[177] Hans Bösch, "Germanisches Nationalmuseum," in *Nürnberg: Festschrift Dargeboten Den Mitgliedern Und Teilnehmern Der 65. Versammlung Der Gesellschaft Deutscher Naturforscher Und Ärzte Vom Stadtmagistrate Nürnberg*, ed. W. Beckh (Nürnberg: Johann Leonhard Schrag, 1892), 444-45.
[178] Siegmund Günther, *Leopoldina* 1878 (1878): 93-95.

organizers sought to straddle two positions, both serving specialists' scholastic interests and appealing to the broad public. Some organizers' concern with authenticity was evidently an attempt to avoid putting on show "good-enough" displays that could not stand up to specialist scrutiny. Director of the Germanisches Museum August von Essenwein was not in favor of presentation of ensembles illustrating a particular period unless all the objects were obtained from comparable historical circumstances.[179] Oskar von Miller at the Deutsches Museum wanted, wherever possible, to find and obtain the original lens that had been mounted in an historically important telescope. Several organizers indicated that their aim was to serve educational purposes, either explicitly, or by stating their desire to provide an ordered series of apparatus. Some organizers clearly wanted their displays to seem organized and were attentive to having the items on exhibit bear connection to their neighbors.

At the Germanisches Nationalmuseum, Essenwein looked to create a "scientific whole" in the disposition of objects.[180] He noted that, in order for viewers' understanding of the contents of the scientific division not to form "in an isolated way", there were also items from the library and graphic arts intermixed with the apparatus, "giving a view of the scope and development of the different sciences."[181] Giving a sense of the rigor of his museum philosophy, Essenwein maintained the hope with regard to the subsequently formed Central Pharmacy Museum set up within his institution that "through unified contributions of diverse specialists in the history of pharmacy, a precise descriptive catalogue…in which the history of each individual item would be considered" would emanate from it. This, he noted, would need to be preceded by a

[179] Hochreiter, *Vom Musentempel Zum Lernort: Zur Sozialgeschichte Deutscher Museen 1800-1914*, 85.
[180] Anonymous, "Neunundzwanzigster Jahresbericht Des Germanischen Nationalmuseums," *Anzeiger fur Kunde der deutschen Vorzeit Neue Folge* 30, no. 1 (1883): 32. Bösch, "Germanisches Nationalmuseum," 444.
[181] Anonymous: 82.

thoroughgoing study of historical sources.[182] It is interesting to note that the museum's guidebook stated that the reconstructed pharmacist's laboratory "invited [visitors'] *study* [my italics]".[183]

Admittedly, certain organizers of historical scientific displays were less critical or sophisticated in their thinking or in sorting through what was exhibition-worthy and what belonged with what else, or in considering whether too many exemplars of certain specific types of items diluted the understanding they conveyed. The increased level of German activity in the display of the history of science did not guarantee that all displays were equally thoughtfully arranged and pedagogically effective. Nor did it guarantee that popularization did not sometimes dilute the potential learning that could have been generated by a display handled somewhat differently. The Liebig Museum, to take one example, included paraphernalia associated with the master chemist, along with implements with which he operated in the laboratory, letters, and writings—potentially generating a pervasive sense of Liebig the person, thereby perhaps de-emphasizing the protocols necessary to his discoveries (or to those of chemistry generally). We might even say that certain of the German Empire displays, viewed from the present-day perspective, were almost sure to leave a mish-mash of impressions.

In their efforts to popularize and put in wider circulation a measure of an awareness of the history of science, some organizers may have shortchanged their displays' value to experts and specialists. The content of a number of displays leads to an impression that the aim was more to give a smattering of the historical dimension of (one or more) sciences to their visitors, rather than to provide an in-depth appreciation of aspects of their pasts or of the gradual build-up of

[182] August von Essenwein, "Das Mit Dem Germanischen Nationalmuseum Verbundene Historisch-Pharmazeutische Centralmuseum," *Anzeiger des Germanischen Nationalmuseums* 2 (1888): 25.
[183] Anonymous, ed. *Wegweiser Des Germanischen Nationalmuseums* (Nürnberg: Germanisches Nationalmuseum, 1901).

natural knowledge. Even Oskar von Miller, head of the Deutsches Museum, the most didactic of all the exhibitions being considered, stated that he wished he could draw in his visitors like the midway did—in other words, in droves. But Miller was insistent that all the museum's artifacts on display were cogently labeled allowing the visitors to get a distinct idea of their function and/or importance, and there were illustrative placards, charts, and some visitor-operated demonstrations. Soon after opening, experts led tours through the museum's sections, and even the museum guards were routinely trained and tested to guarantee their knowledge of the artifacts in their care.

Some other organizers had a less finely developed sense of their visitors' needs. In the better part of the German Empire displays, the use of extensive explanatory media and other aids to enrich their visitors' historical and scientific experience was lacking. The idea in a number of them was that the visitors would autonomously conduct themselves through the collection of display items, reading their simple identifying labels, while any wider or deeper connections were left to them to draw for themselves. Disciplined approaches to museum and other display were still very much in their early stages.

A less easily demonstrated but arguable impact of the scientific historical displays and exhibitions was their help in repairing some of the incoherence unsettling exponents of a unified "German culture".[184] Prominent historian David Blackbourn has assessed that a clear majority of those included in Germany at its unification in 1871 disliked or were only tepidly disposed toward the state.[185] Scientific masterworks on display could serve as part of the glue holding together the various elements of the nation. The Deutsches Museum's Oskar von Miller, in 1909

[184] Suzanne L. Marchand and David F. Lindenfeld, "Germany at the Fin-De-Siècle: An Introduction," in *Germany at the Fin De Siècle: Culture, Politics, and Ideas* (Baton Rouge: Louisiana State University Press, 2004), 153.
[185] David Blackbourn, *The Long Nineteenth Century: A History of Germany, 1780-1918* (New York: Oxford University Press, 1998), 264.

at a large gathering of persons supporting it, expressed the wish that "gradually the regard for the masterworks of scientists and of engineers will become as much a common property of all civilized peoples of the earth, as already for centuries the love of art has been."[186] He might have been meaning at the same time that a piety for German scientists would with time infuse all parts of the nation.

By helping to stitch together a network in the history of science, the temporary displays, along with permanent exhibitions, contributed to forming one of the elements of the history of science's early institutionalization outlined in the introduction. It is also germane to associate this specific form with the needs and aspirations of the new nation. The German political unification in 1871 and the simultaneous declaration of a German Empire made its proponents anxious to create symbols and adduce traditions that would help consolidate it. These conditions, apart from Italy, were not present in the other scientific nations of the nineteenth century, and so may enter into an explanation of why Germans mounted such a number of temporary historical scientific displays (as well as significant new permanent exhibitions) in this period. Each, some more than others, of these displays, along with more permanent exhibitions whose descriptions will proceed in the next chapter, had a bearing on the formation of a network of individuals in Germany who advanced or followed the development of the field of the history of science. The displays also, embodying a spectrum as to what periods, cultures, and fields of science were addressed, contributed to enlarging the range of manifestations of German Empire interest in the history of science. Displays were sustained throughout the Empire to join with later developments elsewhere beginning in the 1920s that fully consolidated the field of the history of science.

[186] Anonymous, "Verwaltungs Bericht Über Das Sechste Geschäftsjahr Und Bericht Über Die Sechste Ausschuss-Sitzung Des Deutschen Museums," (Munich: Deutsches Museum, 1909), 29.

Displays thus satisfied three of the criteria for its (proto-) institutionalization given in the introduction.

THE LONDON INTERNATIONAL SCIENTIFIC EXHIBITION OF 1876

During the German Empire, Germany sought on multiple occasions to show off its science abroad, including historic Germanic science. The first of these occasions, and the first occasion on which a boldly new emphasis in exhibition culture was given overall to the sciences, and in particular to the physical sciences, was the 1876 London International Exhibition of Scientific Apparatus, or as some referred to it, the Special Loan collection. The Special Loan Collection served as the starting point upon which the subsequent exhibitions of history of science and instruments, including the full range of displays of the German Empire, were based.[187] The 1876 London event was in fact an expression of the same bourgeois ascendancy that had brought about exhibition culture with its dazzling point of departure in the World's Fair (or Great Exhibition) of 1851 in London. I give much attention to the details of this event because, while it was British-originated, it proved to be a launching pad for the display of science and its history, galvanizing German awareness of the possibilities for public representation of science, and particularly German milestones in science, that would shed glory on the new nation. Germans definitely were second behind only the host Britain in their showing at the Special Loan Collection, and they would subsequently prove to be the most intensive exhibitors of science and its past during the period of the German Empire.

The London exhibition was a new recognition of the centrality of the science of that time socially, politically, militarily and economically. It put science in the foreground as it had never

[187] Martin Weiss, "'Monuments of Science': How the Teyler Museum's Instrument Collection Became Historical," in *Cabinets of Experimental Philosophy in Eighteenth-Century Europe*, ed. J. A. Bennett and Sofia Talas (Leiden: Brill, 2013), 206.

previously been at any international event and had been at only one national site.[188] Previous to the London exhibition, science had had a certain role at world's fairs—remember: begun in 1851 in Britain—through the inclusion of a division for contemporary philosophical instruments, composed of scientific and musical instruments, while objects of technology and engineering were one of the highlights of world's fairs.[189] Distinguished museum historian Kenneth Hudson writes that "international exhibitions made governments and the leaders of taste recognize that science and the useful arts were the proper concern of the community as a whole."[190] At the 1876 London science exhibition, the riches of modern science were not only on display on their own in a major showcase, but by the inclusion of *historically significant* scientific instruments and relics they were shown to have come down from a great scientific tradition.

Competing with the Philadelphia World's Fair of the same year (1876), the London exhibition of science made its bid to succeed on the world stage, as another symphony to strong capitalist society led by the middle classes. And now, even the privileged status of art as the mark of refinement was being challenged. *The Times* exulted that "…such a sight as the Queen will see today when she opens the Museum [the exhibition] is without a parallel in history…The world of art and of letters had advanced for long before science was considered to be anything more than a craze, more or less harmless...If all the art treasures of Rome, Florence, the Hague, Amsterdam, Antwerp, Bruges, Paris, Dresden, Munich, Berlin, London...were to be brought together...the Loan Collection is the exact equivalent, as regards science..."[191]

[188] A prior site, an 1865 exhibition displaying about five hundred pieces of physical and mathematical apparatus just of Dutch makers put on by the Dutch Society for the Advancement of Industry, was much smaller.
[189] Jim Bennett, *Science at the Great Exhibition* (Cambridge, U. K.: Whipple Museum of the History of Science, 1983).
[190] Kenneth Hudson, *A Social History of Museums: What the Visitors Thought* (London: Macmillan, 1975), 41.
[191] Anonymous, "Loan Collection of Scientific Apparatus," *The Times*, May 13 1876, 13.

The historical component of the exhibition struck some part of its visitors as its most interesting aspect. *The Times* said: "To deal only with dated instruments, we have 531 years of scientific work recorded, with scarcely one important blank, few experimenters of the first order whose names have come down to us being unrepresented."[192] Henri Tresca, assistant director at the *Conservatoire des arts et métiers*, a key French institution involved in the exhibition, wrote "that we will certainly never see a comparable assembling of historic apparatus, extending back to the beginning of the era of scientific observations."[193] The German-born but later British-naturalized William Siemens, a chairman of one of the conferences specially organized for the science exhibition, commented that it was "the most comprehensive collection of models of scientific apparatus—both of modern and of ancient—which has ever been brought together."[194] The value accorded by contemporaries to the historical element at the exhibition was confirmed by J.W. King, American Chief Engineer of the Navy who in an official report cited the London *Times* (unspecified edition): "To the scientific man, if not to the general public, the most interesting objects in an exhibition of this kind are the actual instruments by which celebrated investigators discovered the truths with which their name is associated."[195] The German participant Ernst Gerland attested to the success of this aspect of the exhibition in 1882: "[t]he number of historically notable instruments sent [to the exhibition] was very great, while the attention which they stimulated was not less."[196] That visitors saw the 1876 exhibition as a novel and perhaps uniquely circumstanced chance for the general public to view *historical* objects of

[192] Ibid; also cited in part in "The Press on the Loan Collection," *Nature* 14, no. 342 (1876): 41.
[193] Henri Tresca, "Exposition D'instruments Scientifiques Au Musee De Kensington À Londres En 1876," *Annales du Conservatoire des arts et métiers* 10 (1876): 725.
[194] Anonymous, *Conferences Held in Connection with the Special Loan Collection of Scientific Apparatus 1876 -- Physics and Mechanics* (London: Chapman and Hall, 1876), 216.
[195] James Wilson King, *Report of Chief Engineer J.W. King on European Ships of War and Their Armament, Naval Administration and Economy, Marine Constructions and Appliances, Dockyards, Etc., Etc* (Washington, D. C.: U. S. Government Printing Office, 1877), 381.
[196] Gerland, "Beiträge Zur Geschichte Der Physik: Versuch Eines Verzeichnisses Der Bis Auf Unsere Zeit Erhaltenen Originalapparate," 43.

science was apparent in one British account which claimed that the relics were the reason why ninety percent of visitors came to it.[197]

The exhibition ran for eight months, as did world's fairs. A lengthy catalogue was produced for it, which was also translated into German, the only foreign language so accommodated, at the request of the German commissioners. Henri Tresca alluded to the exhibition catalogue which "must be considered a scientific book in which one finds precious information over and over again".[198] There were about one thousand two hundred exhibitors and about twenty thousand total objects.[199] Accompanying the exhibition were public lectures and a set of conferences of scientists, at which German scientists were present. A number of instruments loaned for the exhibition were made over to the South Kensington Museum (later a portion of which was to become the initial Science Museum in London) at its conclusion.

Despite the build-up of the exhibition as a great showcase for science, Germany, however peerless its contemporary science, was not among the earlier nations to sign on to the event. By the end of 1875, it had still not made a committment. Certainly, this reluctance did not reflect the potential contributions Germany could make to either the contemporary or the historical apparatus on display. But Germany was exhibition-weary, having been heavily involved at the 1873 Viennese World's Fair and being in the process of readying for the 1876 Philadelphia World's Fair.[200] In the event, it took a significant convincing of their Crown Prince and Princess by British officials to galvanize the German participation. Sir Cunliffe-Owen, Director of the South Kensington Museum, at the orders of the Duke of Richmond, who as the Lord President of

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[197] A Scientific Student, "A Museum of Scientific Apparatus," *English Mechanic and World of Science* 583 (1876): 282.
[198] Tresca, "Exposition D'instruments Scientifiques Au Musee De Kensington À Londres En 1876," 735.
[199] Richard A. Thompson, "Appendix D. South Kensington Museum. Report of the Acting Director," in *Twenty-Fourth Report of Science and Art Department* (London: Science and Art Department, 1877), 489.
[200] August Wilhelm Hofmann, "Vorwort," in *Bericht Über Die Wissenschaftlichen Apparate Auf Der Londoner Internationalen Ausstellung Im Jahre 1876*, ed. August Wilhelm Hofmann, Heinrich von Achenbach, and Adalbert von Falk (Braunschweig: F. Vieweg, 1878), viii.

the Privy Council and the head of the Committee of Council on Education was the highest authority supporting the exhibition, approached the German Crown Prince Friedrich Wilhelm about the project.[201] This overture brought forth both his and his wife's, the Crown Princess Victoria's, support.[202]

The earlier apparent reluctance gave way to an all-out final few months of German activity leading up to the opening. Ultimately, the German effort at London was an assertion of national achievement and spirit. August Wilhelm von Hofmann acceded to the request by the German Crown couple to take up the leadership of Germany's participation in the London exhibition. According to Hofmann, the British could not rest content with the absence of Germany, "where science has experienced a spread unlike that in any other land."[203] Hofmann was a renowned German research chemist and scientific organizer. In 1865, he had returned to Germany after highly productive years in Britain heading up the Royal College of Chemistry at the Royal School of Mines in London. Hofmann's determination for the German "Fatherland['s] participation [at the London exhibition] to achieve in the interests of science…in outstanding fashion as befits its full capacity,"[204] illustrates well the German expectations that the event would help magnify German scientific renown as well as Hofmann's own budding devotion to charting the past achievements of both fellow German scientists and of some non-German counterparts. Subsequently, Hofmann continued to be much involved with the history of science, writing many impressive scientific obituaries of chemists for the German Chemical Society's

[201] Ibid., ix.
[202] Anonymous, "Sitzung Vom 10. Januar 1876 - Ausstellung Wissenschaftlicher Apparate in London," *Berichte der deutschen Chemischen Gesellschaft* 9, no. 2 (1876): 1.
[203] Hofmann, "Vorwort," viii.
[204] Anonymous, "Sitzung Vom 8. Mai 1876," *Berichte der deutschen Chemischen Gesellschaft* 9 (1876): 653.

journal *Berichte* (Reports), and also delivering historical talks on more general scientific themes at public events.[205]

Within days, spurred by Hofmann's many connections, a network of local branch committees including many renowned scientists formed, eventually to number forty, covering the entire German nation.[206] One German journal noted the German organizers' resolve "to win the widest circles for a worthy submission to the exhibition on the part of Germany."[207]

The Crown Prince and Princess received the chief scientists of the German Empire in early 1876.[208] Hofmann addressed the Prince and Princess in a printed report dated March 1876 and so published just ahead of the exhibition's opening. He noted in it that the first task had been to expand the body of those Germans involved so as to include all branches of the exact sciences. Hofmann and others who were drawn into the committees he set in motion, as they set about enlisting sponsors of loan objects, had the advantage of being able to invoke the German Crown Prince and Princess as supporters. It would have been clear to the various German departmental authorities that the national interest would be served through putting forth an impressive collective showing. The "most undoubtful guarantees" for the success of the German participation at the exhibition were grounded in the royal interest in the affair.[209]

From the German standpoint, one of the biggest attractions for the participation in the event was the British intention to pay for the shipment of the historical apparatus from all foreign lands as well as to provide for insurance coverage of all the historical items. The German

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[205] Regine Zott, "Justus Liebig Und August Wilhelm Hofmann: Gemeinsamkeiten Und Besonderheiten," in *Die Allianz Von Wissenschaft Und Industrie: August Wilhelm Hofmann (1818-1892): Zeit, Werk, Wirkung*, ed. Christoph Meinel and Hartmut Scholz (New York: Weinheim, 1992), 145.
[206] August Wilhelm von Hofmann, *Bericht Des Deutschen Comités Für Die Internationale Ausstellung Wissenschaftlicher Apparate in London* (Berlin: Comité für die Internationale Austellung Wissenschaftlicher Apparate, 1876), 2.
[207] Anonymous, *Die Fortschritte der Physik* 34 (1884): 29.
[208] "Medical News," *The Lancet* 107, no. 2732 (1876): 74.
[209] Hofmann, *Bericht Des Deutschen Comités Für Die Internationale Ausstellung Wissenschaftlicher Apparate in London*, 6.

participation in the historical aspect of the exhibition was also undoubtedly advanced greatly by the guarantee of the British government to pay for the unpacking, arrangement, and repacking of both historical and contemporary items.[210] Further, help with the logistics within Germany was provided by a British agent who helped plan the shipping of the objects from different points within Germany to the port assigned for their transport overseas. The objects to be shipped to Britain would be accompanied on their train ride within Germany and on their boat ride to London by British personnel. Likewise, there was an assurance that security of a high order, provided by the British, would be in force during the run of the exhibition.[211]

In this grand arena, Germany submitted its scientific artifacts to a high-profile temporary exhibition for the first time. Very soon, other comparable German events followed. Although England had set things in motion by hosting the 1876 display, it was left to the German Empire's scientific activists to make historical display their own. It is ironic that Germans were only reluctantly at first drawn into involvement—for they would be its chief beneficiaries, in terms of seizing on the precedent to then during the Empire mount their own impressive series of historical scientific displays. The failure in Britain to turn the London exhibition of 1876 into a projected national museum of physical science was just one (the attempt in Britain in this period to found a Ministry of Science also ran aground) among various signs that in England, science struggled to attain the support from government that was readily apparent within the German Empire.[212]

The exhibition must have had considerable impact on Germans and the other foreigners who saw it. Such a presumption can be gauged not only by the subsequent stream of German

[210] "Vorwort," viii. Anonymous, "Sitzung Vom 10. Januar 1876 - Ausstellung Wissenschaftlicher Apparate in London," 2.
[211] Hofmann, "Vorwort," viii.
[212] Roy Macleod, "The Support of Victorian Science: The Endowment of Research Movement in Great Britain, 1868-1900 " *Minerva* 9, no. 2 (1971): 220.

displays and exhibitions during the Empire. Revealingly, many years later, in 1903, Eugen Hartmann, the president of the Frankfurt Physical Society, wrote in a letter to the founder of the Deutsches Museum Oskar von Miller, that he was reminded by a recent visit to London of the 1876 scientific exhibition there and the important historical attention it had given to science. Hartmann recalled the "collection which harbored the masterworks of a [William] Herschel, a [Carl Friedrich] Gauss [two renowned German-born scientists, though as an adult Herschel had emigrated to Britain] and all the intellectual heroes which have prepared the way for the natural scientific age."[213]

By according present and past German scientific apparatus a high-profile internationally, the 1876 London exhibition set the stage for more efforts by German organizers to show off German science in subsequent displays at home and abroad, initiatives that lent substance to Germany's general claims of having a national tradition. Just as present-day scientific achievers contributed to overall German prestige, the new Germany's "national past"—an invented tradition, in that Germany had never previously been one unified polity, that pulled together a disparate group of customs, laws, language, and forms of governance—stood to be made a more potent bulwark for the present by the inclusion of past German scientific achievers. The words of the editors of a special edition of *Osiris* in 2009 on "Science and National Identity" suggest the work required by newly formed national entities to secure their claims of historical roots: "[n]ations required efforts of construction, invention, and imagination rather than simply identification; they were never already there waiting to enter history", and idealizing their past science was a primary resource in this regard.[214]

[213] Eugen Hartmann, Correspondence to Oskar von Miller Letter Number 02821, Deutsches Museum Archives, Munich, Germany, June 24 1901.
[214] Carol Harrison and Ann Johnson, "Introduction: Science and National Identity," *Osiris* 24, no. 1 (2009): 4.

Through the London Special Loan Collection in 1876, Germany as a new nation was being offered an opportunity to put itself into the international public eye in the area that was its particular forte, sciences. Previous to the 1876 display, various German academies, institutes, university departments, private collections and government offices had over the decades and centuries conserved their relics of science, more often than not haphazardly. Professors, academicians, and officials would have been the guardians, students and others might have gained permission to view the holdings, but these in many cases were restricted to the few items held at any particular site. The 1876 exhibition opened a new window for the public to access these items. As Hofmann confirmed, many were the scientific societies, universities and technical schools from whom the German organizers successfully solicited loans for the London exhibition. Further, support came from the German ministers of education, trade, war, and the navy, and beyond these from all authorities whose help or permission the German central organizing committee solicited.[215] Several of these, based in Prussia, were the head of the Army General Staff, the General Postmaster, the director of the academy of trades, the directorship of the mining academy, the director of the Royal Library, the heads of the Royal Academy of Sciences, and the German Chemical Society. And the branch committees also experienced great support from corresponding heads of departments in German provinces other than Prussia.[216] The extent of this support helps explain Germany's outstanding showing at the exhibition.

The actual time available to the various German committees to assemble their objects amounted to little more than two months, once the late decision had been taken by the Crown Prince and Princess to move the German participation forward. There was the likely prospect

[215] Hofmann, "Vorwort," xiii.
[216] *Bericht Des Deutschen Comités Für Die Internationale Ausstellung Wissenschaftlicher Apparate in London*, 5.

that the German contributions would show themselves to be "full of holes".[217] In "diversity and interest" of items the Germans nevertheless managed "to stand worthily alongside other nations".[218] That the German organizers' goals were met is apparent from comments made in the Forward to the *Reports on Scientific Apparatus at the London International Exhibition in 1876* issued in 1878 under Hofmann's editorship. He indicated that at first, when the assembly of German items was doubtful, the organizers had felt they could not bring in the organizational support of the state but had to rely on their own efforts. But, as Hofmann expressed it, they then felt that the "deed was achieved", only at that point considering it appropriate to call on the German state to take on the task of sending reporters to give a documentation to it—a step which the state did indeed undertake. The Empire's government thereby clearly recognized the value to the German nation of promoting an awareness of the scope of the exhibition and of the German participation in it.[219]

GERMAN UNDERTAKINGS FOR THE EXHIBITION

The greatest weight of the German presence at London in 1876 was its contemporary scientific apparatus, which was indeed only second to that of the host Britain in the number of exhibitors and the number of exhibition items. The Germans were recorded as having 311 individual exhibitors and twenty-five hundred items.[220] (The actual number was higher, since these figures were generated while additional entries were still coming in.) More German exhibitors had participated than the number of the German exhibitors of scientific apparatus (127) at the Viennese World's Fair in 1873, which was remarkable in that the German

[217] Ibid., 6.
[218] Ibid., 8.
[219] "Vorwort," xviii.
[220] *Bericht Des Deutschen Comités Für Die Internationale Ausstellung Wissenschaftlicher Apparate in London*, 7.

preparations for the London event (unlike those for the 1873 Fair) had been conducted in such a short span of time.[221]

Compared to those of other nations, British lenders had by far the most impressive set of historic scientific apparatus. Germany, like several other nations, contributed some iconic pieces in the history of science, but alongside its strong contemporary apparatus presence, its historical showing was more comparable to that of the other guest nations. The primary sources of Germany's historic apparatus were the Kassel collection and the items assembled by the local committee in Breslau. But perhaps the signature German pieces of apparatus, two original air pumps and two hemispheres of Otto von Guericke of the mid-seventeenth century, the first of their kind used to demonstrate the possibility of a vacuum, were loaned from the Royal Library in Berlin and from the municipality of Brunswick. Berlin also sent thermo-electric and induction apparatus (from the early to mid-nineteenth century) of Seebeck, Nobili, Melloni, and Antinori, and one of the two extant exemplars of a late-eighteenth century German calculator. Frankfurt sent telegraphic apparatus made by Soemmerring in the first decade of the nineteenth century, with the claim to have been the first electrically-based telegraph constructed. The city of Bochum in Westphalia sent a compass marking declination, or the difference between magnetic north and true north, with sundial, from 1597. Strassburg sent the famed moon charts of astronomer Tobias Mayer of 1750. Göttingen sent photographs of the telegraph apparatus of Gauss and Weber, of two of Gauss's heliotropes, long-distance surveying instruments reflecting the sun's rays, and of his magnetometer and other apparatus for the study of terrestrial

[221] "Vorwort," xvi-xvii. The total number of German exhibitors at Vienna had been eight thousand, according to Reuleaux's article in Das XIX. Jahrhundert in Wort und Bild Volume 3 (Berlin: Deutsches Verlagshaus Bong, 1900), 192.

magnetism. Württemberg was represented by the second exemplar of a German-made calculator from the late eighteenth century.[222]

Of the items assembled by the German exhibitors, it is notable that a number of them were not designed by a German. There would be inclusion of items not made in Germany in many subsequent German historical scientific displays. It suggests that while Germans were in good part motivated by national pride as they organized such displays, they were also intrigued by the historical development of science overall, and were in specific instances attuned to key contributions made by non-German scientists. Further, inclusion of non-German relics in German displays better supported their presentation of *lines of development*, which was the approach adopted at many German displays.

Rudolf Biedermann, who later was a writer on technical chemistry and on patent law, was one of the two Germans who were posted to London for the duration of the exhibition, and he functioned as a kind of executive director for the German element of the proceedings. His diverse organizational and linguistic talents helped ensure that the German presence at the London exhibition was a worthy one. In producing the German edition of the exhibition catalogue, he added some material to what was found in the original British edition. It was Biedermann, also, who translated into a German edition the *Handbook* of essays initially commissioned in English by the British exhibition organizers, which was comprised of challenging essays on several scientific topics by prominent British scientists. Further, Biedermann served as the person to whom those German scientists desiring to participate in the scientific conferences accompanying the exhibition should apply.[223] Lastly, he ensured that all

[222] Ernst Gerland, "Bericht Über Den Historischen Theil Der Internationalen Ausstellung Wissenschaftlicher Apparate in London Im Jahre 1876," Ibid., ed. August Wilhelm Hofmann, Heinrich von Achenbach, and Adalbert von Falk, 119.
[223] Anonymous, "Sitzung Vom 8. Mai 1876," 654.

the items received in England from Germany were sorted by the proper category for their display.[224]

Biedermann commented that the German version of the catalogue had more pointedly presented the scientific character of the exhibition than had the British catalogue, and he thought that the "uses of the great enterprise" would be rendered more lasting in the form of an "encyclopedic reference work", and would be extended to those who could not attend, by the German catalogue.[225] In it, he made reference to the "higher, nobler" endeavor that this exhibition represented compared with the intent of other exhibitions—meaning industrial exhibitions and world's fairs. The German nineteenth century proponents of science liked to represent their scientific enterprise as not only formidable but also idealistically-motivated, a characteristically German sleight-of-hand.

Germany as a new nation had the chance to step up and match long-standing nations in their dedication to showing off science. J. Scott Russell told a lecture audience during the exhibition:

> You must be astonished, as I was, to see the wonderful collection which the German people have sent here of their educational apparatus and of their mechanical apparatus of every kind; and you will be pleased to know that it was with the entire concurrence of the German Government, and, I believe, by the powerful influence of some of the most elevated people in Germany, that a vote was given that they should cordially assist England in this great attempt of hers to educate her rising generation to enable them to perform great achievements in science and its application.

Germany's outstanding participation, all the more surprising given the limited time it had had to prepare, was highlighted in Russell's continuing remarks, as if decreeing to all non-

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[224]Hofmann, *Bericht Des Deutschen Comités Für Die Internationale Ausstellung Wissenschaftlicher Apparate in London*, 8.

[225] Rudolf Biedermann, *Bericht Über Die Ausstellung Wissenschaftlicher Apparate Im South Kensington Museum, Zu London, 1876: Zugleich Vollständiger Und Beschreibender Katalog Der Ausstellung Mit Holzschnitten* (London: Strangeways, 1877), xvii, xxviii.

German nations the joint award of subsidiary rank among the foreign participants: "We have received also from several other nations, Belgium , France, Italy, and many nations, valuable contributions of the same kind."[226] The German organizer Hofmann, writing of the collection of the historical scientific relics, spoke of "not only England, but also Germany, Italy, France, Holland and Spain…[which] have sent valuable objects.[227]

German historical scientific objects that had not come together on any previous occasion were forwarded on to the exhibition site in South Kensington. Germany sent two agents to London, one of them the aforementioned Rudolf Biedermann, to conduct any necessary interactions on site with the British authorities, to aid with the set-up of display items, and to be available for visitors in talking about the displays. The Empress of Germany came to Britain and joined Queen Victoria in a preliminary royal visit to the exhibition before its official opening.[228]

Along with scientists from several other nations including France, the Netherlands, and Italy, German scientists took part in a week of conferences on sciences in May, where some attention was given to historical apparatus.[229] Thirty-five Germans came to be part of the conferences, in response to the "lively hope" of the English Exhibition Commission that numerous Germans would attend.[230] Germans served as vice-presidents of all the sections, that is, of the physics, mechanics, chemistry, and biology sections and finally of the joint section for physical geography, geology, mining, and meteorology. The conferences were conducted in

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[226] H. W. Chisholm, "Standard Weights and Measures," in *Free Evening Lectures Delivered in Connection with the Special Loan Collection of Scientific Apparatus* (London: Chapman and Hall, 1876), 522.
[227]Hofmann, "Vorwort," xviii.
[228] Anonymous, "The Opening of the Loan Collection," *Nature* 14 (1876): 52-53.
[229] *Conferences Held in Connection with the Special Loan Collection of Scientific Apparatus 1876 -- Physics and Mechanics*.
[230] James Hooker, "President's Address: The Loan Collection of Scientific Instruments," *Royal Society Proceedings* (1877): 344-45.

German, French or English, a recognition of these three countries' importance to contemporary science.[231]

SUMMING UP THE EXHIBITION

Assessing the historical items assembled at London as a whole, there were a good number of iconic pieces from earlier centuries, reflecting the rise of experimental science in the seventeenth and eighteenth centuries, but it was the nineteenth century including its earlier decades that was most heavily represented. As one French participant noted, "…thus, for the first time, the means of the discoveries of Allesandro Volta, of Faraday, and of André-Marie Ampère are to be seen under one roof."[232] There were very few items of non-Western origin: a Chinese compass and a model of Egyptian musical pipes. Western items from earlier centuries extended back in time to the Roman era.

The exhibition did not include books portraying instruments. This is interesting, for subsequent German historical scientific displays often did include books and manuscripts. It did however include some laboratory notebooks, and British seamen William Dampier's, James Cook's, William Bligh's, John Franklin's and William Parry's log-books. Ernst Gerland mentioned that there were some letters of famous scientists.[233] There were original *designs* of the first needle telegraph (loaned by the Imperial German Telegraph Department), of the first European passenger steam-boat, the English "Comet", and of the air-pumps of Christian Huyghens, Robert Boyle and Robert Hooke, and Francis Hawksbee.[234] There were a couple

[231] Anonymous, "Sitzung Vom 8. Mai 1876," 654.
[232] *Conferences Held in Connection with the Special Loan Collection of Scientific Apparatus 1876 -- Physics and Mechanics*, 86.
[233] Gerland, "Bericht Über Den Historischen Theil Der Internationalen Ausstellung Wissenschaftlicher Apparate in London Im Jahre 1876," 3.
[234] Ibid., 83.

reproductions of important documents, those of the chart made by Christopher Columbus's pilot Tuan de la Coas and of the drawing with Galileo Galilei's idea for a pendulum clock, the first ever conceived. Most all of these classes of objects would be represented subsequently at German history of science displays.

Because the size of some objects which might have been deemed historically significant enough to forward on to the exhibition from abroad would have made their transfer impractical, "it was resolved at the commencement of this present year [1876] to extend the [exhibition] collection to *models* [my italics] of inventions recording scientific progress, and different scientific societies were invited to co-operate in forming collections of such models."[235] The stage was thus set for models to sometimes be included during the German Empire in subsequent historical displays relating to science.

Photos were sent of a number of items. A similar step was later taken at its start by the Deutsches Museum where, alternatively, sometimes, when a particular item was not available, a drawing of it or a replica was substituted (see below on the Deutsches Museum's substitutions). At London, there was no personal paraphernalia of scientists. This "personal" side of science was, however, occasionally incorporated into future German displays, indicating the advent of a more popular element there.

A formal style was adopted at the 1876 Special Loan Collection in regard to how to set off the exhibition items. Ornately-legged wooden cases housed certain display items, seen in the only photograph still existing of the 1876 exhibition (according to the Museum Keeper of the present-day Science Museum in London.) This photograph, of the southern gallery, shows important relics including James Joule's set-up for measuring heat generated by motion, Galileo's telescope, and Lavoisier's calorimeter. (A narrow corridor seen in the photograph led

[235] Anonymous, "The Exhibition of Scientific Apparatus," *The Engineer* (1876): 342.

to a second building which presented smaller instruments.)[236] A similar elegance and order would later also characterize the presentation of some of the relics at the Deutsches Museum.

There was some attempt at showing developmental series, a practice that was favored in many subsequent historic scientific displays in Germany. Although there was a range of opinions on the effectiveness of the exhibition's *organization*, one French account demonstrated appreciation by some journalists in that nation for what had been realized. "In the exhibition, there is a truly scientific tendency, everywhere order, a methodical presentation, everywhere serious materials of instruction."[237] An article in the *Daily Telegraph* cited by a *Nature* report on the press's reaction to the exhibition found that

> ...all intending visitors...may employ, to inestimable profit, half a long day in looking at object after object...[T]he inevitable fatigue of studying attentively a vast scientific museum is reduced as much as possible by the perfection of system and method, in classifying the objects, and in placing them well within view.[238]

However, the emphasis at London was on getting together the most famous relics of science, and less on grouping of items. In a generally favorable article in the *Journal of the Society of Arts*, there was a mention of this flaw: "[t]hough the arrangement of the collection at South Kensington generally is very creditable to those officers upon which this difficult task has devolved, it, nevertheless, seems a pity that exhibits relating to each other should not have been brought more together..."[239]

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[236] Peter DeClercq, "The Special Loan Collection of Scientific Apparatus, South Kensington, 1876. Part 4: Photographs and Copies," *Bulletin of the Scientific Instrument Society* 76 (2003): 11. The same photograph has also been published online as "Room 2 of the Loan Collection, South Kensington Museum, London, 1876" as part of an article in Volume 1 of the online journal Science Museum Group Journal written by Robert Bud, "Responding to Stories: The 1876 Loan Collection of Scientific Apparatus and the Science Museum," *Science Museum Group Journal*, no. 1 (2014), http://journal.sciencemuseum.ac.uk/issues/spring-2014/.
[237] François Franck, " L'exposition D'appareils Scientifiques De South Kensington Museum (Londres)," *La Nature* 4, no. 161 (1876): 75.
[238] In Daily Telegraph May 13 1876, cited in "The Press on the Loan Collection," *Nature* 14, no. 342 (1876): 42.
[239] Anonymous, "The Loan Collection of Scientific Apparatus at South Kensington. Botany and Vegetable Products," *Journal of the Society of Arts* 24, no. 1247 (1876): 980.

As of September, five months into its run, one-quarter million visitors had come to the event.[240] The President of the British Association for the Advancement of Science, in his address at its 1876 meeting, spoke highly of it: "[t]he Loan Exhibition of Apparatus at Kensington has been a complete success, and cannot fail to be useful, both in extending a knowledge of scientific subjects and in promoting scientific research throughout the country."[241] For the *Quarterly Journal of Science*,

> the great success of the present Exhibition has been widely proclaimed by the whole of the public press…we suppose we may take the present Exhibition of scientific Apparatus as a proof that Science will henceforth have its position acknowledged in the deliberations of the Government of England, and receive some small share of the money expended for the honour and welfare of the country.[242]

At the conclusion of a series of scientific lectures given by British scientists during the exhibition, as Chair, noted engineer J. Scott Russell said:

> … for the first time you see collected a large museum of instruments and apparatus which represent the great triumphs of human intellect and human science made during the last few centuries, and especially characteristic of the marvelous progress of science during the century in which you and I have the good fortune to live and work**.**[243]

Rounding out international approval, Walther von Dyck in 1903 judged that the exhibition's organization had been praiseworthy. The exhibition,

> of the greatest significance for the historical and scientific aims of the South Kensington Museum…[had been mounted] on the basis of a comprehensive plan and most carefully prepared…Under the cooperation and the most liberal support of the governments, the scientific and technical institutes and also the specialists and technologists of all Europe took an outstanding role.[244]

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[240] Hooker, "President's Address: The Loan Collection of Scientific Instruments," 344-45.
[241] Thomas Andrews, "Address of Thomas Andrews, President," in *Report of the 1876 Meeting of the British Association for the Advancement of Science* (Glasgow: John Murray, 1877).
[242] Anonymous, "The Loan Collection of Scientific Apparatus at South Kensington," *Quarterly Journal of Science* 13 (old series) (1876): 370.
[243] Chisholm, "Standard Weights and Measures," 493.
[244] Walther von Dyck, *Über Die Errichtung Eines Museums Von Meisterwerken Der Naturwissenschaft Und Technik in München* (Leipzig: B.G. Teubner, 1905), 7.

But there were other, less flattering, British verdicts on the exhibition. Perhaps not entirely admiringly, one writer in the *English Mechanic* sneered that if the London exhibition could be transformed into a permanent museum, "…along with the really 'educational' objects, the attraction to the general public might come from a display of 'historical' objects, so the taxpayer would feel he was getting an 'exhibition' for his money."[245] In *The Engineer*, a report bruited that "it was rightly thought that simply to show such objects [as apparatus, models and drawings] under glass cases would not enlighten the public generally as to their use and value," so the organizers' staging of *conversaziones* and conferences in conjunction with the exhibition, where attendees could glean more information, was welcomed.[246] More damning and replete with ire, another contribution in the *English Mechanic* had it that

> …the show was born in charlatanism/ cradled in humbug/ nursed in quackery/ weaned on gammon… To the man of science, who visits it with a previous familiarity with any special type of instrument, it cannot fail to possess much that is most instructive...[N]o moderately well-educated man or woman can well stand wholly unmoved before...original instruments of Galileo, nor regard the telescope made by Sir Isaac Newton...without curiosity and profit…but it is just this impossibility of permitting… [the average Special Loan Collection visitor] to do more than gaze at the mere outside of the largest proportion of apparatus exhibited, which, in our view, destroys nearly all the value of the exhibition as a means of education…[T]hese [Special Loan Collection] conferences are to be confined to people with some claim—more or less just—to be considered men of science…The legitimate object...of such an exhibition...is to educate the *people* whose money goes to provide it; and here we fear that it must break down hopelessly.[247]

But these were the words of one of the personal foes of the British chief exhibition organizer Norman Lockyer.

The national rivalry between France and Germany would be reflected in the press reaction to the exhibition. False pretense regarding past scientific achievement was the charge in

[245] Student, "A Museum of Scientific Apparatus," 282.
[246] "The Exhibition of Scientific Apparatus," *The Engineer* (1876): 342.
[247] Anonymous, "The Show at South Kensington," *English Mechanic and World of Science* 582 (1876): 241.

an article in the French journal *L'Électricité* with respect to labeling of certain relics sent to the exhibition from Germany.

> …Number 1632 is assigned to an electrical telegraph *supposedly* [italics added] ...constructed in 1809 in Munich by H. Sommereux [the spelling should have been Soemmerring].
>
> Since the appearance of our last issue, a scandal has brewed in Berlin. An anonymous author has published a pamphlet unseating Oersted as the discoverer of the action of current on a magnetised needle, giving the credit to a predecessor of Poggendorf. This aroused outrage in Copenhagen...
>
> Sommereux's plan [for an electrical telegraph], entirely unrealizable, had no practical value. One may only claim in disregard for any justice that this Bavarian dreamer is the inventor of the telegraph. He attempted long-distance communication by [electrical] decomposition of water and evolution of gas. Not only did he need as many electrical wires and tables as letters [in the alphabet], but it is known that emission of bubbles because of polarisation is of a great irregularity. The true telegraph is the telegraph by electro-magnetism...The credit for the invention traces back to Arago and to Ampère.
>
> To establish the inferior rank of the Germans [in early telegraphy] and their lack of rights to claim the invention of the electrical telegraph, it is enough to take a look at catalogue number 1611, which is the shapeless telegraph conceived by Steinhal [the spelling should be Steinheil] of Munich in 1837, the same year that the great Wheatstone [of England] established his needle telegraph and gave to all telegraphy such a powerful impulse.[248]

ERNST GERLAND'S REPORT ON THE HISTORICAL SIDE OF THE 1876 EXHIBITION

As mentioned above, Germany sent of a delegation of thirty-five reporters to spend weeks at the exhibition and write a series of reports on the different areas of science. This was unique among the participant nations, as even the host Britain did not issue any post-exhibition reports. The German reporters were sent out (and paid) by two government departments, those for Commerce and Trade and for Intellectual, Educational and Medical Affairs. Hofmann delivered a verdict: "[o]nly through such a report, which promises a rich mine of instruction equally for [Germany's]... technical people and for [its]…upcoming scientists, will the great

[248] H. d'A., "L' Électricité Á L'exposition De South Kensington," *L'Électricité* 6 (1876): 82.

sacrifices made by the exhibitors for the exhibition be fully redeemed in the interest of our Fatherland."[249] Though not for the previous facets of the exhibition, the German government now officially fully took on the responsibility for managing this concluding step, thus recognizing the exhibition's importance for national purposes. The reports were, overall, similar in length and content to the lengthy reports written under official authorization by the German government on the divisions of world's fairs.

In the published collected German reports on the London exhibition, the one on the historical component, more than one hundred pages long, appeared as the first. Ernst Gerland, co-author of a publication on the Kassel Museum's exhibition items sent to the London event, wrote the report. Corroborating the good sense of the German government in providing financial support for the publication of the post-exhibition reports, Walther von Dyck, mathematical display organizer in 1892-1893 and co-director subsequently of the Deutsches Museum, commented in 1903 that the report was "an important contribution to the history of the individual branches of natural science."[250]

An interesting mention in the volume of collected German reports on the exhibition was that the German domestic press had not given any more than a superficial account of the London exhibition. It was therefore incumbent on it, Hofmann mentioned in the volume's preface, to make known the importance of the event, providing detailed information for the German public who were non-attendees, as well as "to extend the usefulness of the exhibition" to those Germans

[249] Hofmann, *Bericht Des Deutschen Comités Für Die Internationale Ausstellung Wissenschaftlicher Apparate in London*, 9.
[250] Dyck, *Über Die Errichtung Eines Museums Von Meisterwerken Der Naturwissenschaft Und Technik in München*, 34 endnote for page 7 paragraphs 2 and 3.

who had been able to visit it."[251] Gerland's report, in 1878, added to this benefit for German non-attenders.

In his report, Gerland wrote that the visitors were shown "the development of the individual branches of the observational and experimental sciences in a way never before" achieved through the presentation of "the most valuable" of the sciences' historical apparatus. In order to summarize the historical component of the exhibition, Gerland had to engage in his own critical assessments of the history of some apparatus, for "not adequate preliminary [scholarly] work" was a problem in many instances.[252]

Gerland did not shrink from denoting some display items as showing "nothing further [that is] remarkable".[253] He gave a negative judgment to the whole category of the items gathered to illustrate the history of the science of sound.[254] He even cast a back-handed slap at the number of scientific items displayed belonging to the famous British chemist John Dalton, "all too completely" assembled through reverence for Dalton.[255]

Gerland took issue with what was asserted in the exhibition catalogue at various points. He referred to a rheostat (variable resistor), which the catalogue posited was given by Faraday to Charles Wheatstone; but, Gerland noted, this design was exactly the one commonly called a Wheatstone rheostat. Another example of his correcting an attribution came in his treatment of a voltaic pile ascribed to William Wollaston. He noted that the pile was consistent with what commonly was portrayed as a Wollaston pile, but that it was not configured in the way

[251] Hofmann, "Vorwort," xviii.
[252] Ernst Gerland, "Bericht Über Den Historischen Theil Der Internationalen Ausstellung Wissenschaftlicher Apparate in London Im Jahre 1876," Ibid., ed. August Wilhelm Hofmann, Heinrich von Achenbach, and Adalbert von Falk, 1-2.
[253] Ibid., 30.
[254] Ibid., 42.
[255] Ibid., 2.

Wollaston had first suggested. He instead ascribed it to another maker, William Babington.[256] Gerland also corresponded with other scientists to become more informed about the relics he was reporting on.[257] He lauded William Thomson (Lord Kelvin) "whose work alone has made possible the most large-scope achievements of the modern era" in undersea telegraphy;" it is interesting to note, given Gerland's praise of Thomson, that Thomson had favored Gerland with helpful information prior to preparation of Gerland's report.[258]

Gerland was attentive on occasion to the provenance (succession of owners) of the pieces in his report, such as of a chronometer used by Captain Cook in his major exploratory voyages and of the Guericke air-pump held at the time of the exhibition by the Berlin Royal Library.[259] He eloquently portrayed the way that scientific relics undergo vicissitudes, suggesting that particular care must be taken to prevent permanent loss.

Gerland further took interest when an historic relic was lost from view, and then sometimes retrieved. For instance, he told of the fate of one telescopic lens made by Huyghens that for long was counted as lost and long afterwards recovered from amongst a chest containing a number of old lenses of the physical cabinet of Utrecht.[260] Another illustration recited the loss of the body and ocular of a telescope by William Herschel when a Spanish observatory where it mounted was turned into a fort by French invaders. Gerland mentioned another lens, probably produced by the early seventeenth century Dutch maker Zacharias Janssen, long passed down in a private family, but without any documents affirming its origination.[261] He further indicated the identification of a trove of seventeenth century thermometers used at the Florentine *Accademia*

[256] Ibid., 94.
[257] Ibid., 29.
[258] Ibid.
[259] Ibid., 18, 36.
[260] Ibid., 47.
[261] Ibid., 49-50.

del Cimento, found in the early nineteenth century in a pile of glassware not clearly demarcated.[262] And he referred to his own identification of a couple thermometers of Daniel Fahrenheit in the Leiden University collection several years previously.[263] His imputation was that what needed preservation were not only aged items themselves but the links to their history—that is, who had used them and for what experiments.

The impact of Gerland's report was not a minor one. It was subsequently cited in the publications of other authors, achieving its credibility and usefulness through Gerland's thorough discussion of details, attempts to argue from the evidence, and comprehensiveness. One source referred to it as a work that gave a picture to the reader "of the development of the individual branches of the observational and experimental natural sciences in a way that had never happened before".[264] It may not be going too far to say that the report, extensive and scholarly as it was, alerted some of the figures who later participated in mounting German displays, to the significance and public impact enjoyed by the 1876 London exhibition, the first high-profile temporary, partly historical, scientific exhibition.

THE GERMAN AFTERMATH OF THE 1876 EXHIBITION

The German experience in 1876 at London kicked off an attention to the history of science that persevered in a variety of contexts in Germany during the rest of the Empire period. The message brought back was several-fold: the display of objects at temporary sites was meaningful as a form of national or regional representation; historical scientific objects were

[262] Ibid., 71.
[263] Ibid., 72.
[264] Johannes R. Wagner, "Bericht Über Die Wissenschaftlichen Apparate Auf Der Londoner Internationalen Ausstellung Im Jahre 1876," *Jahresbericht über die Leistungen der chemischen Technologie für das Jahr 1879* 25 (1880): 519.

inherently fascinating and rewarding to learn about, particularly as a means of giving more contextualization for the contemporary advance of sciences.

Without its German participation, the London exhibition would certainly have suffered. Concomitantly, the experience of the exhibition seemed decisive in launching Germany on further initiatives to showcase the history of science objects. German liking for the historical component of the London exhibition is apparent in the comment by Hofmann that this element was the exhibition's "ornament', consonant with a remark in the exhibition's official British handbook that "objects of historic interest from museums and private cabinets, where they are treasured as sacred relics" have been loaned.[265] Hofmann commented that the great success of German organizing for the exhibition in such a short time derived in part from the rightness of the preconditions on which the British hosts built the idea for an exhibition of scientific apparatus, but it was also a testament to German readiness in the service of science.[266] One German reviewer of the German reports on the 1876 London event exulted: "One can no doubt state that Germany claimed next to Britain the most outstanding place at the exhibition."[267]

In retrospect, the London 1876 exhibition seems to have been a pivot point, at which the momentum in regards to display and documentation of history of sciences began to pass from Britain—well-suited, it had appeared in 1876, to celebrate science and its history in a major exhibition—to Germany. Britain's scientists had been highly enthusiastic about the holding of the 1876 scientific exhibition. One hundred thirty-four of them had signed on within weeks of the initial call put out for consideration of the event by the Committee of Council for Education in January 1875. In a single month, from May to June 1875, the groundwork of the five British

[265] August Wilhelm Hofmann, *Globus* 29, no. 19 (1876): 303. *Handbook to the Special Loan Collection of Scientific Apparatus 1876 (South Kensington Museum)*, (London: Chapman and Hall, 1876), xii.
[266] Hofmann, "Vorwort," ix.
[267] Anonymous, *Die Fortschritte der Physik* 34 (1884): 29.

preliminary exhibition committees including their classification decisions was pulled together into a cohesive program; "[n]othing could better manifest the lively interest that was inspired by the exhibition in England." Then, shortly after the opening of the exhibition, a hundred twenty British scientists signed a memorial to the government requesting the introduction of a physical science museum with "both the history and the latest developments of Science."[268] The holding of the exhibition itself had been imbued with profound hopes for a permanent science museum in Britain, as Henry Chisholm said in one of the exhibition's scientific presentations: "it is a new future...and let us hope that this is therefore the nucleus of a new museum to be entrusted...to the same able hands which have brought this together, to be collected in larger halls with much greater opportunities for shewing [*sic*] the treasures of science than even this collection gives us..."[269]

But unfortunately, Britain proved unable to capitalize in any significant degree on the precedent of the 1876 exhibition, except as a fledgling platform that decades later would eventually become a national science museum. Despite the promising start—more than one thousand one hundred and fifty scientific objects added, many of them loaned for the exhibition, to the South Kensington Museum in 1877, the year succeeding the exhibition—the British languished in their efforts to make any headway towards a national science museum. There was a "log-jam of committees" besetting the future of the South Kensington science collections.[270] In addition, there were antagonists to what some deemed a move to favor a clique administering the science affairs in South Kensington that threw an additional monkey-wrench into the project.[271]

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[268] "Memorial Praying for the Establishment of a Museum to Contain Scientific Apparatus: Appendix A," in *Minutes and Correspondence to 24th Report of Science and Art Department* (London: Science and Art Department, 1877).
[269] Chisholm, "Standard Weights and Measures," 523.
[270] R. G. W. Anderson, "Connoisseurship, Pedagogy or Antiquarianism: What Were Instruments Doing in the Nineteenth-Century National Collections in Great Britain?," *Journal of the History of Collections* 7, no. 2 (1995): 220-24.
[271] Anonymous, "Letters to the Editor " *English Mechanic and World of Science* 590 (1876): 458.

On the other hand, the memory of the 1876 exhibition remained alive for German museum contributors and gave a precedent to the subsequent German display organizers. They received impressions of how an exhibition covering science, including its history, could serve to bring luster to the host nation. During the remainder of the German Empire they would erect an array of temporary and permanent sites for this purpose. Hofmann extolled in 1878 that "numerous historically noteworthy items were brought together from the most different regions of Germany" for the London exhibition.[272] In 1905, Ernst Gerland remembered the 1876 London exhibition as the origination point for much of the interest in the history of science in Germany and the other nations that had transpired in subsequent decades. He postulated that the exhibition had "opened the door for increased public interest internationally in history of sciences"[273] Also in 1905, Walther von Dyck, second of the three-man directorate of the Deutsches Museum which was to open the next year, in a published version of his 1903 rectoral address at the Technical University of Munich on the founding of the Deutsches Museum, included in the notes that the historical report of Ernst Gerland on the 1876 exhibition "shows, how great the number of original apparatus is, which was brought together there in London through the responsiveness of all the cultural nations."[274] Exhibition expert Otto Witt wrote in 1906, in an encyclopedia entry on exhibitions, that the London exhibition had been a prime example of the special meaning attaching to exhibitions with a particular focus.[275] All these testimonies, nearly thirty years after the event, indicate the lasting legacy of the participation in, or the awareness of, the 1876 exhibition.

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[272] Hofmann, "Vorwort," xvii.
[273] Ernst Gerland, *Deutsche Revue* 30, no. 2 (1905): 374.
[274] Dyck, *Über Die Errichtung Eines Museums Von Meisterwerken Der Naturwissenschaft Und Technik in München*, 34 endnote for page 7 paragraphs 2 and 3.
[275] Witt, "Naturwissenschaftlich-Technische Ausstellungen," 414.

The London 1876 exhibition has undergone vicissitudes in the historiography even among thewriters in English. Among these, it had all but disappeared from view for a time as a significant milestone or moment in the history of British science. But this period of neglect of the 1876 exhibition has been somewhat corrected recently. Peter deClercq's several articles emphasize the historical component of the exhibition. In a 2010 volume covering the history of the Science Museum (London), a chapter by Robert Bud gives an account of the founding years of the museum, including some details on the 1876 exhibition, following which he more specifically addresses the exhibition in a 2014 article.[276] In 2008 the exhibition's *Handbook* was made available by the South Kensington Museum as a facsimile edition. In 2011 the final version of the British exhibition catalogue was re-issued by the Cambridge University Press. The German historiography has done little to date with this signal event or the significance of the German participation in it. Its relatively obscure standing even today should not detract from the fact that it was in some ways signal in its time, remembered not only in Britain by those who hoped to overcome the barriers to forming a national physical science museum, but in Germany, where a sudden build-up in attention to history of scientific apparatus came with its participation at the London exhibition. We can arguably date the start of the late-nineteenth century rise in appreciation of science's historical apparatus to London in 1876; the German continuation of its

[276] Frank Greenaway, "More Than 'a Mere Gazing Place': The Special Loan Exhibition and the Science Conferences of 1876," in *Making Instruments Count*, ed. R. G. W. Anderson (Aldershot: Variorum, 1993). Peter DeClercq, "The Special Loan Collection of Scientific Apparatus, South Kensington, 1876. Part 1: The 'Historical Treasures' in the Illustrated London News," *Bulletin of the Scientific Instrument Society* 72 (2002). "The Special Loan Collection of Scientific Apparatus, South Kensington, 1876. Part 2: The Historical Instruments," *Bulletin of the Scientific Instrument Society* 73 (2002). "The Special Loan Collection of Scientific Apparatus, South Kensington, 1876. Part 3: Contemporary Publications," *Bulletin of the Scientific Instrument Society* 74 (2002). DeClercq, "The Special Loan Collection of Scientific Apparatus, South Kensington, 1876. Part 4: Photographs and Copies." Robert Bud, "Infected by the Bacillus of Science: The Explosion of South Kensington," in *Science for the Nation: Perspectives on the History of the Science Museum*, ed. Peter Morris (New York: Palgrave Macmillan, 2010). Bud, "Responding to Stories: The 1876 Loan Collection of Scientific Apparatus and the Science Museum."; See also Vitor Bonifácio and Isabel Malaquias, "Portugal and the 1876 South Kensington Instrument Exhibition," *Quaderns d'Història de l'Enginyeria* 13 (2012).

spirit in the succeeding decades through an array of further displays was essential in securing that appreciation.

DISPLAYS INVOLVING A PROFESSIONAL BODY

A subset of the German Empire temporary historical scientific displays were those organized by or for a professional body's membership. The membership could demonstrate that the profession was venerable in age through such a historic display (or through a permanent exhibition in the later case of pharmacists' support of the Germanisches Nationalmuseum's pharmacy division and physicians' support at the same museum's medical cabinet.)

THE GERMAN SOCIETY OF PHARMACISTS 1879 DISPLAY

In 1879, just three years after the 1876 London exhibition, the recently consolidated German (national) Society of Pharmacists (the prototype society had existed since 1835; the national society formed in 1872) assembled its first modest historical section of sixty-one items as part of their eighth annual meeting's display. One periodical account reported that the historical component "was an entirely new exhibition realm" at the Society of Pharmacists meetings.[277] A second journal owned that the display contents might have been inscrutable to a non-specialist but were captivating to those in the know. [278] The nearness in time to the London exhibition (and to the 1878 appointment of the historical scientific division, covered in the following chapter, at the Germanisches Nationalmuseum) reveals how riveting the history of German science was proving to be in the first decade of the new nation of Germany. Germans

[277] Anonymous, *Pharmaceutische Zeitung* 24, no. 73 (1879): 561.
[278] Wolfgang Schneider, "Gründung Und Aufbau Des Pharmaziegeschichtlichen Museums in Nurnberg Durch Hermann Peters," in *Festschrift Zum 65. Geburtstage Von Georg Edmund Dann Am 22. Juli 1963*, ed. Georg Edmund Dann and Wolfgang-Hagen Hein (Stuttgart: Wissenschaftliche Verlag-Gesellschaft, 1963), 135.

were taking pride in their new polity, and finding ways to incorporate past German achievements as part of a national tradition.

The 1879 pharmacists' display seems to have been the first historical scientific temporary display offered by any national professional body in Germany. The guiding hand was an upper-level civil servant in public health and owner of a vintage Hannover pharmacy, the *Ratsapotheke* (Pharmacy at the Town Council), named Emil Prollius. He called on the members of the pharmaceutical profession to rummage through their premises looking for old apparatus and documents and medicament jars distinguished by art or beauty.[279] As its organizer, Prollius saw the planned display as a way for the contemporary members of the pharmaceutical profession in Germany to bid for the recognition of its merits within a new national context. Here the roots being explored were professional as much as national. But since Germans had been very early involved in apothecary practice, extending back centuries, the display could perform significant national work too in showing the depth of the German scientific roots. The items brought together for the display went back as far as the fourteenth century.

Hermann Peters was Emil Prollius's assistant at the *Ratsapotheke* when the 1879 Hannover display was organized. It is thus very likely that he participated in the proceedings. Peters would, as covered in the next chapter, become the instigator and organizer of the far larger Pharmaceutical Central Museum within the Germanisches Nationalmuseum.

The 1879 historical pharmaceutical display, a modest start, was an admonition for German pharmacy to do more with its past. Attesting to its patriotic potential was the resonance that particular figures of past pharmacy had as patriarchs not only of the German sciences but of German culture in general. Chief among these heroic pharmacists was the sixteenth-century

[279] Ibid., 134.

Middle Ages figure Paracelsus, whose chemical knowledge had been so precocious. Pharmacy's past was always intertwined with the practices of medicine and chemistry.

The display included old preparatory pharmaceutical apparatus and utensils. In addition there were publications, manuscripts and illustrations pertaining to the practice of pharmacy in past times. Rounding out, and putting an element of social history into, the exhibition, were two other categories of display items. One was a set of original documents, such as pedagogical letters and certificates attesting to the education and proper status of apothecaries from the times when their work was still guild-based. The other was composed of the objects that traditionally pharmacist's premises installed decoratively, such as traditional ornate containers for medicaments.

A small exhibition, the 1879 Society of Pharmacists display would have primarily reached the members of the profession, as such making a circumscribed contribution to extending the network of people joined together by their involvement in the history of science. Its significance may have resided primarily in its being a first instance of a temporary historical scientific display held within Germany. The display showed the pharmaceutical profession to be a patriotically active element in the German collective. As a body that with the unification of Germany had in 1872 reconfigured itself to be a national entity—having previously been regional, specifically north German—its interests now lay alongside those of the new nation. Implicit was the understanding that pharmacists could serve in the larger enterprise of putting Germany on the world map. Taken together, Germans' role in several display events from 1876 to 1879 gave a jump start to the budding interest in the field. These events illustrated a quickly emerging German awareness that historical achievement in science, like contemporary science,

reflected well on the new nation.

THE GERMAN GEOGRAPHERS MEETINGS' HISTORICAL DISPLAYS

The German Geographers meetings were soon to begin a series of historical scientific exhibitions. The historical interest displayed at these meetings forms the best example of a continuation throughout the German Empire of the history of science displays by any one group, and acted not only to promote the German geographers' collective identity but to an enlargement on the wider German stage of the sense that scientific history was important.

Four years after the 1879 apothecaries' exhibition, then, at the third geographers' meeting of 1883 in Frankfurt, another first historical exhibition to honor a newly nationally-based German professional society was mounted, showing the continuity of the mounting of such displays during the German Empire, and building on the small network of practitioners and aficionados of the history of science already in place. Both apothecaries and geographers had, once the nation was founded in 1871, formed national organizations from earlier regional organizations. After an all-German meeting of local/regional geographical societies in Frankfurt in 1865, before national unification, a first meeting of the new *national* society took place in Berlin in 1881: the German geographers too were proving themselves to be an important component of the new nation, showing off the roots their profession could provide for it. But of course this effort also conveyed to the geographers themselves their profession's rich past.

Like the apothecaries, the German geographers staged displays from the start of the national organization's meetings, at which contemporary geographical arts and apparatus were featured: cartography as well as products and books relating to geography and the teaching of geography. The second annual meeting of the national society the following year in Halle

duplicated the first in having an exhibition, and made a very modest start on introducing an historical dimension to its exhibition: hand-drawn plans of the cultural-historical geography professor Carl Ritter of Berlin, who had been active from about 1810 and had died in 1859, were on display.[280]

However, the first more substantial inclusion of history came with the third annual meeting in 1883 in Frankfurt, when the proceedings of the meeting spoke of the historical exhibition as having been an innovation. Within the exhibition at Frankfurt, there were local maps of Frankfurt created as far back as 1550, on loan from the city's historical museum, city archive, city library, and the bureau of canal construction. The Frankfurt meeting's historical section also included 198 items, maps and texts, exclusive of historical geographical materials on Frankfurt, out of 1102 total exhibition items, with details about their provenance. These came to the exhibition from libraries all over Germany, and also from two private collections, one of them that of the Bremen historian of geography Artur Breusing, "one of the foremost geographical historians of the past half-century." Among these items, the main emphasis was on editions of maps of the antique Greek geographer Ptolemy, and of those of his early modern followers in various nations. There were also reproductions of old hand-drawn maps and navigational maps. To these was joined a third component, a display of maps showing the historical development of the differentiation of terrain in German cartography from the end of the eighteenth century, "a concise history of cartography within its restricted realm which we have not possessed until now." During the meeting proper, rarities were displayed for part of two days to interested participants, with oral commentary given by a library expert. The organizers

[280] Anonymous, ed. *Verhandlungen Des Zweiten Deutschen Geographentages Zu Halle Am 12., 13. Und 14. April 1882* (Berlin: Dietrich Reimer, 1882), 117-37.

then kept the exhibition open for several days after the conclusion of the meeting, with public access to the display. In all, the library display was visited by about five thousand people.[281]

The objects of the historical exhibition were arranged according to specific and limited categories placed in defined areas, but gathered altogether in a single exhibition area rather than being separated within the spatially distinct national booths. This greatly facilitated visitors' study of the historical exhibition, claimed the report on it in the meeting's *Verhandlungen* (*Proceedings*). Further, the separately published exhibition catalog received mention as a true bibliographical tool, on its strength in not only providing the provenance of loan items, but in those cases where they were replicas, giving the locations, generally in libraries, of the originals.[282]

At the Frankfurt meeting, the director emphasized the importance of conservation of early maps, calling for careful preservation of those already identified and also for the patrons of geographical science to look around for old maps whose identity and value had been lost from view.[283]

To each attendee at the 1883 Society meeting was given a volume, written by Breusing, tracing the course of map-making from its infancy until 1600, and referring where informative to the exhibition's items. German map-making was emphasized. With the prosecution of its 1883 historical display, not only did the society polish its self-image, but through Breusing's publication, provided an example of the nineteenth century German turn to historical scholarship on science, wherein specifically German themes were often emphasized.

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[281] J. Rein and H. Wagner, eds., *Verhandlungen Des Dritten Deutschen Geographentages Zu Frankfurt A. M. Am 29., 30. Und 31. Marz 1883*, Der Dritte Deutsche Geographentag Zu Frankfurt A. M. Am 29., 30. Und 31. Marz 1883 (Berlin: Dietrich Reimer, 1883), 196.
[282] Anonymous, "Die Geographische Ausstellung Zu Frankfurt A. Main 1883," in *Verhandlungen des dritten deutschen Geographentages zu Frankfurt A. M. am 29. 30. und 31. Marz 1883*, ed. J. Rein and H. Wagner (Frankfurt am Main: Dietrich Reiner, 1883), 194-95.
[283] Rein and Wagner, eds., *Verhandlungen Des Dritten Deutschen Geographentages Zu Frankfurt A. M. Am 29., 30. Und 31. Marz 1883*, 7.

As had been the pharmacists' historical display in 1879, this 1883 so-called inaugural historical geographical display was modest in size, but it showcased some genuine relics, and set the stage for the subsequent attention by the German geographers to their history. In distinction to the Hannover pharmaceutical history display, full advantage was seized at Frankfurt to also highlight local identity and local historical roots. No special committee was apparently formed to initiate historical displays in upcoming meetings, but the idea for such displays at the meetings of geographers was carried forward; the sense that historical displays were relevant to the profession was of a piece with the emergence contemporaneously at several other sites of historical displays mounted under the auspices of a profession in Germany, including not only pharmacists but also mathematicians and physicians. Some kind of mutual reinforcement of interest in the historical dimension of science between such profession-organized displays and other German exhibitions like historical scientific displays at world's fairs was apparently taking place.

The fourth German geographers' meeting, held in Munich in 1884, did not in the first planning stages include any provision for a historical section similar to those of the second and of third meetings as part of its contemporary exhibition of cartography, but at the last moment, the organizers decided to display at the meeting the by now usual early cartographic representations of the host city and the general region of Bavaria. These included as the earliest work one from 1526, but others including ones of Peter and Philipp Apian and of Mercator were also very early.[284] Another room offered for inspection a set of maps showing the development of drawing techniques. On one wall were collected examples of advanced technical mapmaking

[284] Anonymous, "Die Geographische Ausstellung Im Hauptgebäude Und Erweiterungsbau Der Königlichen Technischen Hochschule Zu München Am 16. Bis 21. April," in *Verhandlungen des vierten deutschen Geographentages zu München am 17., 18. und 19. April 1884*, ed. F. Ratzel (Berlin: Dietrich Reimer, 1884), 177-78.

of the early nineteenth century. There was an area in one room devoted to biographies of past German geographers, and nearby were old works written by German travelers and geographers.

While with this cartographic assemblage, the Geographers' meeting itself gave a certain amount of attention to history, the Hof- und Staatsbibliothek (Bavarian Royal Court- and Realm-library) in Munich did considerable further work in providing a history display to coincide with the same meeting.

At the Bavarian library a start was made with displaying old *apparatus*. One each of celestial and terrestrial globes of the Ingolstadter Peter Apian, mid-sixteenth century savant and mathematician, were a principal attraction.[285] There were illustrations of the earth, with one of the earth's disc extending back to the tenth century. Also displayed was an Arabic handwritten work from at the latest the eighth century A.D. and a Turkish map of the Mediterranean Sea of the eleventh century. Accompanying these were thirteenth and fourteenth century works on the heavens and on astrology with drawings tinted in color. Works from the sixteenth century on newly opened geographical regions figured in the display, along with portulan atlases (early navigational aids). Sea, regional, and whole-earth maps and maps showing the location of Bavarian wild animals, flowers, castles, ruins, monasteries, and Roman outposts in antiquity filled out the library's display of maps.

The display also offered printed works. Among these, rare were the first printing of Christopher Columbus's letters, and sixteenth century historical assemblages, with tinted illustrations, of the descriptions made by the first European explorers in the West Indies and East Indies. A series of fifteenth and sixteenth century editions of Ptolemy's atlas gave insight into the history of geography during those centuries, as did a fifteenth century map showing Roman roads in Germany and Italy. Finally, a set of broadside (poster-like) calendars spanning the

[285] Ibid., 179.

fifteenth and sixteenth centuries, which had often been attached inside the covers of books, increased the visitors' knowledge of the development of German orthography and printing arts.[286]

In conjunction with the meeting, there were other sites in Munich that aggregated some in-house historical apparatus in displays of objects not considered transportable: the Conservatory of the Army and the Munich National Museum. At these sites, guided tours of their special displays were offered.[287] By continuation of a historical component in association with the Society of German Geographers meetings, the newly nationally-organized profession was making plain that its past contributed strongly to its present sense of its mission. In the process, and by the public access to the displays associated with the meeting, the German geographers were helping extend what was becoming a growing network of those Germans interested in the historical scientific narrative.

At the fifth German Geographers' meeting in Hamburg, a historical section was mounted once more as part of the meeting's exhibition. Old instruments including compasses and sextants borrowed from local sites were arranged within types so as to represent their historical development.[288] The other historical component of the exhibition was ten globes and ten cartographic works by the sixteenth century Cologne geographer Caspar Vopel. Importantly, there was an opportunity for the public to visit the exhibition during the eight days following the

[286] Ibid., 180.
[287] Ibid., 177-81.
[288] H. Michow, ed. *Verhandlungen Des Fünften Deutschen Geographentages Zu Hamburg Am 9., 10. Und 11. April 1885*, Der Fünfte Deutsche Geographentag Zu Hamburg Am 9., 10. Und 11. April 1885 (Berlin: Dietrich Reimer, 1885), 223. Anonymous, "Die Geographische Ausstellung Im Königlichen Polytechnikum," in *Der sechste deutsche Geographentages zu Dresden am 28., 29. und 30. April 1886*, ed. Heinrich Gebauer (Dresden: Dietrich Reimer, 1886), 215-21.

geographers' meeting. During those eight days more than ten thousand visitors, not including meeting participants, saw the exhibition.[289]

It was apparent to the host city's committee and the local geographical society that "specifically Hamburg is most rich in suitable objects for an exhibition" of geography, as a port city which had long been Germany's gateway to distant locations.[290]Of the interesting historical geographical objects relating to Hamburg, about one hundred fifty maps made visible "the development of the city and its environs", joined by maps of the lower Elbe and the North Sea and coastline, which were in use, beginning in the late 1500s, for navigation, and geographical publications dating as far back as the ship's surgeon Friderich Martens' voyage description of 1675.[291] The Naval Observatory of Hamburg provided part of its rich collection of historical apparatus for navigation.[292] One of the meeting's sixteen talks was devoted to historical instruments. Given by Captain Carl Koldewey, in charge of the Hamburg naval observatory's Nautical Instruments department, having commanded in 1868 the first German exploratory and scientific voyage to the Arctic, it was on the historical importance of the compass in world trade. Hamburg demonstrated its *bona fides* as a key German city, with its own measure of scientific enterprise, clear from the mayor's opening speech:

> Our forebears, where opportunity was favorable, did not fail to pursue science actively…Our city's specific character and striving, moving and vivifying everything in it, has been its four hundred years' practice, handed on through generations, of plowing…the sea...That is its mission in history, its position in the German Empire, and there lies the service that it had to achieve, and…[still] achieves as much as it can, for the Fatherland.[293]

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[289] Anonymous, *Geographisches Jahrbuch*, vol. 10 (Gotha: Hermann Haack Geographisch-Kartographische Anstalt, 1888), 671.
[290] Michow, ed. *Verhandlungen Des Fünften Deutschen Geographentages Zu Hamburg Am 9., 10. Und 11. April 1885*.
[291] Ibid., 223-24.
[292] Ibid., 226.
[293] Ibid., 1.

The importance of this meeting, and its exhibition, to Hamburg was remembered in 1898 in a report commemorating the first twenty-five years of the Hamburg local geographical society by its first secretary.

> I think I don't deceive myself, when I grant the Fifth Geographers' Society meeting in Hamburg one of the first places among all the meetings held… The genius of that time, which promised to our overseas ties an unsuspected importance and development to our overseas connections, called our local committee to set before [the public] in word and image the special meaning of our city, as the gateway through which more than any other our Fatherland's relations with remote parts of the world are sustained.[294]

At Dresden, the site of the next Geographers meeting in 1886, although there were exhibitions of several private collections of ethnographic materials, there appears not to have been any historical feature apart from the historical maps of Dresden from the fifteenth century on and the maps of Saxony from the sixteenth century on; such a *local* historical cartographical exhibition had evidently now become a feature of every German Geographers Society meeting.[295]

In Karlsruhe in 1887, on the contrary, a historical section was again mounted as one of four sections. There were three principal sources of exhibition items: the court-territorial library, other territorial collections, and the Grand Duke of Baden's private collection. There was interesting illustrative material schematizing the city from its 1715 founding. Similar material was presented for three additional towns, Mannheim, Freiburg, and Constance. The items included maps, drawings, and views, along with four seventeenth and eighteenth century combined heaven-and-earth globes, most of them unique exemplars and one made by the monks of Salem cloister.[296] The Royal Württemberg regional authority and the school advisory council

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[294] Anonymous, *Mitteilungen der Geographischen Gesellschaft in Hamburg* 14 (1898): 9.
[295] "Bericht Über Den Verlauf Des Sechsten Deutschen Geographentages and Über Die Damit Verbundene Ausstellung," in *Verhandlungen des sechsten deutschen Geographentages zu Dresden am 28., 29. und 30. April 1886*, ed. Heinrich Gebauer (Dresden: Dietrich Reimer, 1886), 216-17.
[296] W. Wolkenhauer, "Der Siebente Deutsche Geographentag," *Deutsche Geographische Blätter* 10 (1887): 153.

of Baden were together responsible for the display of a fifteenth century celestial globe made for the bishop of Constance by astronomer Johannes Stöffler, along with the latter's biography and portrait.[297] Historical cosmographic and travel writings took in the study of the earth's history and the study of peoples. There was also material illustrative of the development of cartography over the long term, including printed and hand-drawn maps from the sixteenth and seventeenth centuries. Two geomagnetic devices constructed in the late eighteenth century by the noted Augsburg constructor Brander, which were intact, unlike the majority of Brander's geomagnetic apparatus by that time, formed another set of historical interest.[298]

Subsequently, there were further historical exhibitions at German Geographers meetings. But the exhibitions year to year varied in their scope. The "extra exhibition" (*Sonder-Ausstellung*) at the eighth meeting in Berlin in 1889 departed from the previous run of Geographers meetings in being limited to the contemporary. The display organizers chose to mount such a reduced display with the rationale that it was already possible to see much historical cartographical material on display in Berlin museums.[299]

In 1895 in the eleventh meeting at Bremen, sea-craft was celebrated, in keeping with that city's role as a maritime hub. One report indicated that, although the directorate of the Bremen branch of the German Geographical Society had stated their uncertainty that it could measure up to previous outstanding geographical society exhibitions at Vienna and Stuttgart, its originator and director Albert Oppel succeeded, by placing its emphasis on Bremen's serving as a gateway

[297] O. Kienitz, ed. *Verhandlungen Des Siebenten Deutschen Geographentages Zu Karlsruhe Am 14., 15. Und 16. April 1887* (Berlin: Dietrich Reimer, 1887), 197.
[298] Ibid., 201.
[299] Anonymous, "Die Geographische Sonder-Ausstellung Zu Berlin Vom 23.-28. April 1889," in *Verhandlungen des achten deutschen Geographentages zu Berlin am 24., 25. und 26. April 1889*, ed. Georg Kollm (Berlin: Dietrich Reimer, 1889), xxxiii-xxxiv.

to the sea, in ensuring that it was "in many points ahead of [those earlier] exhibitions."[300] With the exhibition's historical division featuring old navigational charts or replicas of them from the thirteenth to the eighteenth century as well as a range of historical instruments and globes, there was much to interest those knowledgeable about aspects of seafaring's past, although one report stated that the historical Division 2 may have been relatively neglected by exhibition attendees, who had such options as the pictorial division to fasten their interest.

The charts and maps, including historical ones, relating to sea voyages were the intended central theme of the exhibition. Division 2's full designation was "Historical Exhibition, concerning the development of nautical maps from the thirteenth to the eighteenth century or up to the general introduction of the Mercator-Projection and of the latitudinal minute [1/60 degree] as the nautical mile." Its sections were Collected Editions [of maps], Nautical Charts of the 13th to the 16th Centuries, Nautical Maps of the Era of Discoveries, Nautical General Maps since the Appearance of the Mercator Map of the World of 1569, Nautical maps of European Bodies of Water from the 16th to the 19th Centuries, The Small Rutters [early mariner's handbooks of written sailing directions], The Large Rutters of the 16th to the 18th Centuries, and The Large Sea Atlases of the 17th and 18th Centuries. This was comprehensive coverage of many centuries of geographical tools used in seafaring. Although there were many replicas of these sailing directions, charts and maps, there were a substantial number of originals as well.[301]

Libraries as far away as one in Vienna, a nautical school, a naval station, a university geographical institute, a geographical society, and the Germanisches Nationalmuseum all contributed loans of historical navigational charts. Small pilot books from the fifteenth century on, mainly originals, were also part of the exhibition. Among these was a copy of the sole printed

[300] Willhelm Ule, "Der Xi. Deutsche Geographentag in Bremen: Ii - Die Geographische Ausstellung," *Geographische Zeitschrift* 1, no. 1 (1895): 54.
[301] Paul Dinse, "Die Geographische Ausstellung: Iii - Die Historische Abteilung Der Ausstellung," Ibid.: 58.

portulan of the fifteenth century, from 1490.[302] Further, as was generally done in exhibitions of geography society meetings, there was a section of maps of the geography and features of the host area, that year's being Bremen and the Lower Wesen River region; this section contained some quite old local maps, extending back nearly three hundred years.

Hermann Wagner, who wrote the portion of the geographical society meeting report providing details on the historical exhibition, and whose private collection of historical atlases and maps yielded a substantial number of the items loaned to the exhibition, also delivered a talk at the meeting, titled "*Das Rätsel der Kompasskarten im Lichte der Gesamtentwickelung der Seekarten*" ("The riddle of the card compass in light of the total development of maps of the oceans".)

One report, in praising the exhibition's "systematic organization", presumably encompassed the historical exhibition as well.[303] The intent of the organizers was that the historical division of the exhibition display typical exemplars to demonstrate lines of development. The exhibition's demonstrated progression through the centuries of sea charts and maps constituted "a completed whole in the greatest thoroughness." [304] Of old navigational instruments, wooden octants, a Jacob's staff, a Davis quadrant, and an astrolabe were represented; some sun-dials also found their way into the exhibition. These were suited to provide to the non-maritime attendees new insights into the relationship between the old navigational instruments and modern ones also on display in the exhibition.[305] Kept open before the start, and after the finish of the Geographers meeting, extended for another eight days, it

[302] Hermann Wagner, "Historische Ausstellung, Betreffend Die Entwickelung Der Seekarten Vom Xiii.-Xviii. Jahrhundert Oder Bis Zur Allgemeinen Einfuhrung Der Mercator-Projektion Und Der Breitenminute Als Seemeile," in *Katalog Der Ausstellung Des Xi. Deutschen Geographentages Geöffnet Vom 14. Bis 21. April in Den Räumen Des Künstlervereins Zu Bremen*, ed. Georg Kollm (Bremen: Verlag des Ortsausschusses, 1895), 43.
[303] Ule, "Der Xi. Deutsche Geographentag in Bremen: Ii - Die Geographische Ausstellung," 54.
[304] Paul Dinse, "Die Geographische Ausstellung: Iii - Die Historische Abteilung Der Ausstellung," Ibid.: 58.
[305] Ibid.

seems to have been quite a success: altogether five thousand people, including members of the public, saw it.[306]

The 1907 meeting in Nuremberg had a most impressive exhibition, centering on the significance that that city had once held, and for a long time, in regard to German science. Cartography was displayed from the time of the city's greatest Middle Ages influence to the time at which it lost its status as an imperial city, that is, from 1475 to 1806, subdivided into several periods. Maps, plans and prospects of the Germanisches Nationalmuseum, the Royal Bavarian Archives, the City Library of Nuremberg, and the University of Erlangen library were all assembled into a display area at the Germanisches Nationalmuseum; the latter provided materials both from its library and its prints collection.[307] The former greatness of Nuremberg map- and globe-making had resulted from the high degree of mathematical skill obtaining there along with the expertise in woodcuts and engraving introduced in the city by Albrecht Dürer. Five round maps with accurate perspective of the sixteenth century were historical treasures. Beyond this, globes were a noted specialty of Nuremberg geographers from the early Renaissance on into the eighteenth century. The visitors to the exhibition could view three fifteenth and sixteenth century Nuremberg globes by Martin Behaim, Johannes Schöner and Johannes Prätorius, as well as the non-Nuremberg globes of Gerardus Mercator and Johannes Stöffler. The Royal Bavarian Archives loaned one of its prize items, a map of one area of Nuremberg from the sixteenth century by Paul Pfinzing, who had personally tracked the Nuremberg area with a compass and a step-measurer of his own design.[308]

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[306] Albert Oppel, "Anhang: Bericht Über Die Ausstellung Des Xi. Deutschen Geographentages Zu Bremen 1895," in *Verhandlungen Des Elften Deutschen Geographentages Zu Bremen Am 17, 18 Und 19 April 1895*, ed. Georg Kollm (Berlin: Dietrich Reimer, 1895), 223.
[307] Johannes Müller, *Katalog Der Historisch-Geographischen Ausstellung Des 16. Deutschen Geographentages Zu Nürnberg* (Nürnberg: Verlag des Ortsausschusses, 1907), 2.
[308] Ibid., 14-17.

Altogether, the German Geographers Society, putting on show historical artifacts, was both part of the new wave of enthusiasm for the history of science in Germany and a stimulant to its further elaboration. An orientation to history was taking hold as part of ordinary business of the German geographers. Because their meetings were itinerant, they gave practitioners at individual sites in Germany a chance to assemble old materials highlighting the development of cartography and, through maps of local regions, the development of settlements of their areas, which in turn aroused pride in local roots. Further, the historical exhibitions extended the sense of professional roots available to the practitioners in the discipline of geography. Finally, these displays, in their emphasis on long-enduring German expertise in the sciences of measurement and cartography, gave acclaim to the nation.

THE MUNICH 1893 MATHEMATICAL EXHIBITION

A subsequent exhibition in 1893 at Munich shows yet another scientific professional organization putting historical artifacts on display. The German Mathematicians Association—itself newly created in 1890 as an offshoot of the Natural Scientists and Physicians meeting—was the seedbed out of which the Munich exhibition sprang. Again, then, a newly-organized or -created German scientific body made efforts to display its field's past, as an affirmation of its ongoing contribution to German life. In fact, coming some decade and a half after the London Special Loan Collection, the Munich exhibition made explicit that the memory of the 1876 London exhibition, and Germany's role in it, had strongly endured in Germany among some circles.

The 1893 event was the first international exhibition representing mathematics as a whole held anywhere, in this respect resembling the London exhibition's being the first such event

representing science as a whole. Walther von Dyck, later key second authority at the Deutsches Museum, and first secretary of the the German Mathematicians Association, proposed such an exhibition at the Association's 1891 meeting, perhaps not fully anticipating that the vast project would then fall almost completely on his shoulders. This was an awesome undertaking for a single person. Not only that, but Dyck essentially had to organize the exhibition twice. Preparations for the exhibit had initially been made in 1892 for the staging in Nuremberg in conjunction with that year's meeting of the Association and just after the Natural Scientists and Physicians meeting, but because of a cholera epidemic in 1892 in Germany, the proceedings for the meetings and the mathematics exhibition had to be delayed a year. Subsequently, the exhibition was held in 1893 in Munich, along with the 1893 Mathematicians Association meeting, while the 1893 Natural Scientists and Physicians meeting took place in Nuremberg.

With the passage of a year, the plan originally formed in 1892 for a week-long exhibition was then converted into a month-long event.[309] This extended exhibition started before the beginning of the Mathematicians Association meeting and did not wrap up until several weeks after the meeting had concluded.[310] Overall, the scientific practitioners' attendance at the exhibition would no doubt have been considerably higher if the 1893 meeting of the Natural Scientists and Physicians had also been held in Munich. Still, during the month that the exhibition ran in Nuremberg, a thousand people visited, so attendees at the Mathematicians Association meeting, numbering a hundred, were far from being the sole exhibition visitors.[311]

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[309] Werner H. Rudowski, "Die Mathematische Ausstellung 1893 in München," in *Computing for Science, Engineering, and Production: Mathematical Tools for the Second Industrial Revolution*, ed. Karl Kleine (Hamburg: Norderstedt Books on Demand, 2013), 61.
[310] Walther Dyck, "Die Münchener Mathematische Ausstellung: Bericht Von Dr. Walther Dyck," *Zeitschrift für mathematischen und naturwissenschaftlichen Unterricht* 25 (1894): 141 page note.
[311] Rudowski, "Die Mathematische Ausstellung 1893 in München," 59. Herbert Mehrtens, "Mathematical Models," in *Models: The Third Dimension of Science*, ed. Soraya de Chadarevian and Nick Hopwood (Stanford: Stanford University Press, 2004), 276.

Dyck personally guided attendees at the meeting of German mathematicians through the exhibition.

Dyck gave an introductory report at the opening of the exhibition, subsequently printed by the *Zeitschrift für mathematischen und naturwissenschaftlichen Unterricht* (*Journal for Mathematical and Natural Scientific Pedagogy*), whose editors stated their conviction of the benefits of enlarging the relatively small circle of those who were able to attend the exhibition in person. In Dyck's report, he cited an 1873 mathematical model display in Göttingen as one predecessor. At Göttingen, where physical models of mathematical functions in gypsum, in zinc and in thread from France and Switzerland were sent along with German display items, no historic items, apparently, were featured.[312] Referring to the London 1876 exhibition of scientific apparatus, with displays of mathematical and physical-mathematical content, as being "of great compass", Dyck considered it the direct forebear of the 1893 mathematical exhibition, which was also of international dimensions, though clearly on a highly reduced scale.[313]

Contributions not only of mathematicians' models but of physicists' instruments utilizing applied mathematics were featured at Munich, with items totaling over six hundred from a hundred seventy loan contributors.[314] The emphasis was primarily on present-day mathematical models and mathematical-physical instrumentation. Dyck conceived his display as being, including its historical dimension, to the honor of the mathematical science on an *international* basis, just as the London exhibition had proclaimed itself to have been to the honor of science

[312] August Gutzmer, "Geschichte Der Deutschen Mathematiker-Vereinigung," *Jahresbericht der Deutschen Mathematiker-Vereinigung* 10 part 1 (1909): 19-24.
[313] Dyck, "Die Münchener Mathematische Ausstellung: Bericht Von Dr. Walther Dyck," 146.
[314] Rudowski, "Die Mathematische Ausstellung 1893 in München," 59.

generally.[315] However, he did allow that the 1893 exhibition's section on physical mathematical models was chiefly devoted to recent *German* developments.

The Bavarian state mediated with the German rail administration, ensuring no-cost transportation of the objects, and financial support came from the Bavarian State Ministry (*Ministerium*) of the Interior for Matters of Church and Education and from its Bureau (*Reichsamt*) of the Interior.[316] The Imperial administration also granted permissions and provided aid (*das Entgegenkommen und die Behilfe*).[317]

The exhibition was mounted in four rooms at the Munich Technical College. Dyck wrote: "[a] large segment of the mathematical, physical, mechanical-technical and geodetic institutes within and beyond Germany…made available models constructed in-house as well as historical valuable objects of their collections. Submissions came from museums, private collections, [and] individual scholars both within and outside of Germany."[318]

Apart from the host nation, America, Belgium, France, Italy, the Netherlands, Norway, Austro-Hungary, Russia, and Switzerland took part. "Especially in Great Britain, a committee was formed, composed of the mathematicians Lord Kelvin, Greenhill, and Henrici, in order to load the exhibition with the most outstanding objects from official and also private collections" in Great Britain.[319]

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[315] Ulf Hashagen, "Der Mathematiker Walther Von Dyck Als Ausstellungsorganisator Und Museumsgründer," Münchner Zentrum für Wissenschafts- und Technikgeschichte, https://www.mzwtg.mwn.tum.de/fileadmin/w00bmt/www/Arbeitspapiere/hashagen_dyck1.pdf., 11.
[316] Walther Dyck, "Einleitung Zu Dem Für Den Mathematischen Teil Der Deutschen Universitätsausstellung Ausgegebenen Specialkatalog," in *Mathematical Papers Read at the International Mathematical Congress Held in Connection with the World's Columbian Exposition, Chicago, 1893*, ed. E. Hastings Moore, et al. (New York: Macmillan, 1893), v [no actual pagination]; Dyck, "Die Münchener Mathematische Ausstellung: Bericht Von Dr. Walther Dyck," 143.
[317] Walther von Dyck, *Katalog Mathematischer Und Mathematisch-Physikalischer Modelle, Apparate Und Instrumente: Unter Mitwirkung Zahlreicher Fachgenossen* (Munich: C. Wolf & Sohn, 1892), vi.
[318] Dyck, "Die Münchener Mathematische Ausstellung: Bericht Von Dr. Walther Dyck," 144.
[319] Ibid.

The historical component embraced original artifacts along with busts of Gottfried Leibniz and Gauss, and paintings of Leibniz, René Descartes, Galileo, and Isaac Newton—a suitable iconology for an event purporting to represent not only mathematics, but to a limited extent, physical science as a whole. Dyck revealed that unsuccessful overtures had been made to procure the loan of perhaps the two most famous relics of mathematical instrumentation, Leibniz's and Pascal's arithmetic calculators. Instead, graphic reproductions of them had to suffice. Three historic calculators were obtained from the Grand Duke of Hesse's museum and from Wilhelm, Earl of Württemburg, while two more were loaned by Franz Reuleux, famous German engineering professor. Seven original calculating instruments from between 1722 and 1809, by Christian Gersten, J.H. Muller, Johann Schuster, Philipp Hahn and others were, however, brought before viewers.[320]

Additionally, integrating calculators from 1853 to the present were arranged as a virtually complete series.[321] Dyck's reference to this is significant, showing his pedagogical rationale for displaying apparatus by developmental series. The display also had a set of historical slide rules (evidently of both linear and circular design), probably displayed as a series, since they had been gathered by the same person who supplied the exhibition with the original calculating machines that were displayed as a series. Another historic centerpiece was a set of models of functions used in mathematical instruction, from French and German collections, reaching back to the time of the students in projective geometry of Gaspard Monge in France in the middle of the first half of the nineteenth century. Mathematical functions embodied in physical form had been becoming in recent years an area of pronounced German activity.

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[320] *Katalog Mathematischer Und Mathematisch-Physikalischer Modelle, Apparate Und Instrumente: Unter Mitwirkung Zahlreicher Fachgenossen*, 146.
[321] "Die Münchener Mathematische Ausstellung: Bericht Von Dr. Walther Dyck," 45.

The catalogue, edited by Dyck, contained 430 pages. It was issued from Munich in 1892, giving a preview of all the work in assembling the objects there that had been done before the cholera epidemic halted the proceedings, and, as Dyck indicated, also revealing gaps among the objects that still might be filled by the next year's enactment of the exhibition. Subsequently, a supplement of 135 pages with additional objects joining the exhibition in 1893 was also printed.[322] The catalogue and supplement contained a good number of illustrations but none of the historical items were illustrated.

The catalogue was a remarkable achievement. The German Mathematical Association deemed it as quite significant in a short summary of the history of the association appearing in 1909, saying that it "will for a long time remain one of the most distinguished and most complete reference works on the existing mathematical and mathematical-physical models and apparatus."[323] The exhibition and its catalog reflected Germany's upsurge in science, and a determination to create an international scientific event, and its documentation, mirroring its counterparts at London in 1876. By incorporating a historical dimension to this profession-based display, Dyck gave mathematicians (and to some extent also those involved in other sciences with a physical-mathematical basis) a sense of the venerable pursuit of their specialty, just as the London 1876 exhibition had done for physical scientists generally. At the same time, the 1893 display reinforced the impression of the German achievements in mathematics and physics, lending strength to the aura of the new German nation while drawing on the scientific prowess associated with the German lands in previous times.

This mathematical exhibition, and in particular its catalogue, has not entirely faded from view. In 1994, Joachim Fischer achieved a centenary republication of the two parts of the

[322] Walther von Dyck, *Katalog Mathematischer Und Mathematisch-Physikalischer Modelle, Apparate Und Instrumente: Nachtrag* (Munich: Deutsche Mathematiker Vereinigung, 1893).
[323] Gutzmer, "Geschichte Der Deutschen Mathematiker-Vereinigung," 8.

catalogue, from 1892 and 1893, along with a brief introduction.[324] In 2011 an article in the European Mathematical Society Newsletter described the supplement part of the catalogue as "well-known".[325] In 2013 appeared a chapter devoted to the exhibition in the proceedings of the 19th International Meeting of Collectors and Researchers of Historical Computing Instruments, with information on Dyck and a series of more recent photographs of the logarithmic instruments that were itemized in the initial catalog and the year-later addendum.[326]

SCIENTISTS AND PHYSICIANS MEETINGS' HISTORICAL DISPLAYS

The meetings of German Natural Scientists and Physicians were regularly accompanied by an exhibition of products and instruments pertaining to contemporary science. But beginning in 1886, there were also several instances of an historical display accompanying the contemporary exhibition. Because of the central role of this body among all German scientists, it was a prominent forum for disseminating new interest in the historical aspect of science. Further, the meetings had been since their inception in 1822 in substantial degree a gathering-point for Germans supporting the unification of the various German lands. After nationhood had been achieved in 1871, a new interest in science's history got underway at the meetings in the 1880s. The meetings came to be a prominent place for its expression.

In 1886, a modest historical exhibition of history of medicine took place during the Berlin gathering, the fifty-ninth such meeting. An historian of medicine at Berlin University, August Hirsch, impelled the proceedings. Although in the context of the 1886 meeting Hirsch was giving historical display some prominence, an opportunity was missed for further

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[324] Walther Dyck and Joachim Fischer, *Katalog Mathematischer Und Mathematisch-Physikalischer Modelle, Apparate Und Instrumente: Nebst Nachtrag* (Hildesheim: New York, 1994).
[325] Jaap Top and Eric Weitenberg, "Resurfaced Discriminant Surfaces," *EMS (European Mathematical Society) Newsletter* (2011): 34.
[326] Rudowski, "Die Mathematische Ausstellung 1893 in München."

emphasizing the influence of the historical, for history of medicine did not appear as a component in the *title* of the meeting section led that year by Hirsch that covered geographical and tropical medicine, and so no special forum for presentation of *talks* relating to history of medicine or sciences took shape this year at the meeting.[327]

Though receiving limited consideration here due to its having taken place within the borders of the Hapsburg Empire, the 1894 Vienna German Scientists and Physicians meeting continued the introduction of the history of science displays at the meetings. A possible source, beyond the 1886 meeting's historical medical display, for the idea of staging an historical display at the 1894 Vienna meeting may have been the 1873 Vienna World's Fair, where there was a division on the history of trades in Austria. One of the two co-organizers of the 1898 Düsseldorf meeting's exhibition, covered below, Karl von Sudhoff, took note of the Vienna exhibition.[328] The display bears notice both because it shows the continuing interest in presenting the history of science in the German lands and forms a link to a much larger venture in a subsequent Natural Scientists and Physicians meeting, the 1898 Düsseldorf exhibition.

Some of the materials presented at the 1894 Vienna historical display were German but non-Austrian, such as letters of Alexander von Humbolt and portraits of physicians of Bavaria and Saxony, which would have found a ready interest among attendees from the new Germany. There were some old geodetic and astronomical instruments.[329] The exhibition was open for the length of the week of the meeting, and was presented in university buildings.

The Vienna display was followed by a major happening at the Düsseldorf 70th Scientists and Physicians meeting held in 1898. Karl von Sudhoff, together with Felix von Oefele, both

[327] Sudhoff, "Aus Der Vorgeschichte Unserer Gesellschaft: Ein Rückblick," 2.
[328] Ibid.
[329] Anonymous, "Katalog Der Ausstellung Der 66. Versammlung Deutscher Naturforscher Und Ärzte," (1894): 62-70.

physicians, staged an event that marked the acceleration within some in this body of an intention to make the history of science more prominent there. Their achievement was an exhibition of over four thousand objects associated with the history of medicine and science, a signal effort based at a high-profile location to put on view the roots of science.[330]

At this year's meeting, the history of medicine was specifically designated as part of the contents of one section in its title. According to the introduction of the catalogue accompanying the meeting, the Düsseldorf event was the first of the Scientists and Physicians meetings to have "a historical exhibition of the whole of medicine and the natural sciences." Certainly the display at Düsseldorf went far beyond the scope of the two previous historical science-related displays at such meetings and was an indication that the history of science was in the ascendant in Germany.

Oefele had independently made plans for an exhibition of "artistically interesting old physical apparatus, surgical instruments, distillation and apothecary vessels, and cultural-historical figures, portraits, and medallions."[331] When approached by Sudhoff with his own idea for a display, Oefele subsumed his project within the plans they drew up together that would also include some natural sciences.

The Düsseldorf exhibition was a kind of manifesto for the history of science. Within the high-profile annual gathering of German scientists and physicians, such a reinforcement about the history of science's importance added significantly to the notice being taken of this dimension of science by an emerging network in that nation. It impressed on the visitors the many centuries during which science and medicine in some form had been practiced. Germans viewing the display could draw inspiration from their own people's part in the long-unfolding

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[330] Albert Wangerin, ed. *Verhandlungen Gesellschaft Deutscher Naturforscher Und Ärzte* (Leipzig: F.W.C. Vogel, 1899), 449.

[331] Karl von Sudhoff, *Historische Ausstellung Für Naturwissenschaft Und Medicin in Den Räumen Des Kunstgewerbe-Museums: Düsseldorf, Juli-October 1898 (70. Versammlung Deutscher Naturforscher Und Ärzte Zu Düsseldorf 1898)* (Düsseldorf: August Bagel, 1898), 5.

advance of science, whose past had a dignity and an instructive value that only by the later nineteenth century was being fully exploited. This direction was taking hold most firmly in Germany in that period.

Sudhoff and Oefele took their idea for an exhibition to the director of the Trades Museum of Düsseldorf. He offered them two floors of the Trades Museum and was said to have brought great skill to bear on the arranging of the medical and scientific relics in it, so that they were suited for instruction.[332] It was he who forwarded a practical plan to work from, with active participation from a local council and from members of the Scientists and Physicians 70th meeting's Medical-historical Section. Other help was forthcoming. The according of thanks in the exhibition catalogue to the Royal Bavarian Minister of Culture suggests the direct participation of his ministry in making contacts helpful for gaining the loans of the display items.

Notification in a contemporary profession journal, the *Pharmazeutische Zentralhalle für Deutschland*, getting the word out in advance to its constituents so that they might contribute loans to the exhibition, revealed that the plans were for both a general section and special displays including "folk medicine, natural scientific instruments, geography, medallions against the plague, festival masks, amulets against illness, and medals and images of researchers and physicians." The desired objects included "herbal books, books on veterinary medicine, books on alchemy and magic, old microscopes, and scales, jars of apothecaries, distillation vessels and other old laboratory apparatus, such as are known to be preserved in old apothecary premises".[333]

To get help in assembling old objects, representatives were chosen both in other German locations and abroad: Amsterdam, Vienna, Würzburg (Bavaria), and Berlin. Further, there was a concentration of people locally who served as consultants and contributors. There were one

[332] Friedrich Helfreich, "Medicinisch-Historische Ausstellung 70. Versammlung Deutscher Naturforscher Und Ärzte," *Münchener Medicinische Wochenschrift* 49 Separatabdruck (1898): 1571.
[333] Anonymous, *Pharmazeutische Zentralhalle für Deutschland* 39 (1898): 613.

hundred twenty-one exhibitors, some from abroad, such as from Vienna and Ghent.[334] The organizers certainly manifested great energy in getting loans from numerous city, state and university libraries and collections. The exhibition ran from July through October, while the Natural Scientists and Physicians meeting took place over six days in the fourth week of September. The exhibition catalogue was two hundred twenty pages.

There was sufficient interest that the two floors of exhibition were crowded, so much so that at certain hours the press was "dangerous". "The instructive showing of entire periods of culture, the generous alternation of the most various objects, and their to most viewers previously completely unknown peculiarities, captured them from the first glance…"[335] The demand for the catalogue was such that it went on to be issued in a second edition. The organizers twice gave tours through the displays.

According to Sudhoff in 1904 as he looked back to the Düsseldorf exhibition, it had suddenly awakened Scientists and Physicians meeting participants to the vitality of the work being done in the history of medicine and science.[336] There was also substantial lecture activity at the Düsseldorf meeting on historical scientific topics, with thirteen talks, the majority of these being medically-related. The two organizers of the Düsseldorf historical scientific exhibition were among those presenting historical topics within the section, Sudhoff presenting twice.[337]

Although the show was meant to encompass both medicine and natural science, the greater part of its artifacts and texts were medical in nature. From Roman Pompeii, there were artifacts including probes, spatulas and suction instruments for the practice of "cupping".

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[334] Frewer and Roelcke, eds., *Die Institutionalisierung Der Medizinhistoriographie: Entwicklungslinien Vom 19. Ins 20 Jahrhunderts*, 111.
[335] Robert Ritter von Töply, "Die Historische Ausstellung in Düsseldorf," *Wiener Klinische Wochenschrift Separatabdruck* 48 (1898): 1103.
[336] Sudhoff, "Aus Der Vorgeschichte Unserer Gesellschaft: Ein Rückblick," 2.
[337] Albert Wangerin and Otto Taschenberg, eds., *Verhandlungen Der Gesellschaft Deutscher Naturforscher Und Ärzte 70. Versammlung Zu Düsseldorf 19.-24. September 1898*, vol. 2 - 2 (Düsseldorf: F. C. W. Vogel, 1898), xiii-xiv.

Depictions of surgical instruments of ancient India also gave this sequence great antiquity. There were numbers of objects which had an historical association with health such as amulets and medallions against scourges. Interspersed with instruments, perhaps confusingly, were statues of gods not only of health but of safety, and scripts of Babylonian and Egyptian exorcisms and prayers.

The exhibition had not only temporal but transcultural diversity. Coptic, Arabic, Greek, Roman and other cultures were represented. An interesting aspect of this exhibition, highlighted particularly in one account, was its making known to a wider public the recent findings in the history of science that had heretofore remained solely the preserve of specialists. Examples were just come-to-light aspects of Greek and Arabic medicine.[338]

The old European scientific apparatus on display relating to exact science extended back to the fifteenth century. Astronomical, navigational, pharmaceutical and geodesic instruments were among the items displayed. In the section comprising the Renaissance and Modern eras, a predominance of astronomical and physical apparatus appeared. These included an armillary, a planetarium (small-scale embodiments of the planets and their orbits), numerous astrolabes, and a globe. There were numerous sun-dials as well, including horizontal, vertical and pocket styles, night timepieces, and two polyedria, instruments with sun-dials on each face to allow finding the time of day from various angles.

But the majority of the exhibition items were writings—whether publications, handwritten drafts, or letters. The books on old folk medicine and alchemy were plentiful. Among the exhibition objects were a variety of Middle Age monastic copies of scientific works of antiquity. In some instances of these, though few, the original still existed.

[338] Töply, "Die Historische Ausstellung in Düsseldorf," 1104.

Two of the exhibition's regional organizers, Friedrich Helfreich and Robert von Töply, wrote reports on it. Both stressed the desire of the two chief exhibition organizers to achieve completeness. This claim could however be sustained moreso for the medical than for the physical sciences side of the display. Töply mentioned, probably with the 1894 Vienna display in mind, that earlier attempts had been made to provide a sense of historical medical practice and medical concepts, but that these had remained "fragmentary". But the Düsseldorf display also had its gaps. While its numerous astrolabes and sundials and several compasses, microscopes and telescopes were important elements, there was little representation of old celestial and earthly globes, nor were there many navigational aids such as quadrants and Jacob's staffs much in use at specific prior eras. Further, there were no apparatus used in geodetic or mining operations such as theodolites or clinometers (for measuring angle of inclination of mine faces and for surveying purposes). There were few representatives of old research apparatus in physical science, including those to investigate light and optics, heat, electricity, and magnetism. The astronomical and physical part of the section for the Renaissance and Modern era, with its apparatus and old written texts was however, if not complete, nonetheless characterized as being clearly and instructively arranged. The organizers had been successful as well in consolidating a good representation of the apparatus and utensils of the early apothecaries, a realm of practice in which the Germans were very early involved.[339]

As regards the significance of objects, Helfreich allowed that the most numerous representatives of Middle Ages Western science and medicine in the exhibition, the monastical documents in Greek and Latin, were significant more because of their age than of their scientific contents. In the botanical and anatomical subsections of the Renaissance and Modern section, the

[339] Helfreich, "Medicinisch-Historische Ausstellung 70. Versammlung Deutscher Naturforscher Und Ärzte," 1570. Töply, "Die Historische Ausstellung in Düsseldorf," 1103.

development of the pictorial representation of natural objects was the primary focus, rather than the development of the science, or apparatus, per se.[340]

Ritter von Töply, in his account, was quite unsatisfied with what was on display in the section on medicine and science in Greek antiquity, noting four different aspects that were untreated. The medicine of Rome was by contrast represented by original apparatus. The contrast between coverage of Greek and Roman medicine likely had something to do with German fascination with their own Roman history. According to Töply, the offerings for the subsection of Middle Ages Arabic and even old Germanic medicine were also meager, while old Indian, Chinese, and Japanese medicine was entirely missing, as were the diverse types of Byzantine surgical apparatus. Töply also felt that there had not been enough discrimination in the selection of, for example, Roman medical instruments, or illustrations of surgical techniques. Overall, he wanted presentation of a full set of *types* rather than exhaustive inclusion.

Surprisingly candid in a piece written by one of the regional organizers was Töply's determination that "the insufficient willingness to sacrifice of so many institutes holding abundant old [surgical and obstetric] instruments has thwarted the gathering together here [in Düsseldorf] of a group of apparatus which could serve as the basis with which the pressing need for a publication of still-extant old original apparatus could be realized." The same author returned to the topic of poor participation by some institutional and personal collectors with regard to the stamp and medals section of the exhibition.[341]

To organizers and advisors of the Düsseldorf exhibition, it seems, the event both aimed for and to some extent achieved solid pedagogical aims. The intent was to gather "not merely an assortment of relics, surviving from past eras but, in connection with suitable means of setting

[340] Friedrich Helfreich, "Medicinisch-Historische Ausstellung: 70. Versammlung Deutscher Naturforscher Und Arzte," *Münchener Medicinische Wochenschrift Separatabdruck* 49 (1898): 1570.
[341] Töply, "Die Historische Ausstellung in Düsseldorf," 1104.

objects forth for inspection, to provide an overview of the development" of medicine and natural science.[342] As in several of the aforementioned displays, the Düsseldorf display may be seen as the expression of one subset of a professional group's desire to locate itself deep in history. Here the professional group was that of practitioners of science overall, and in particular practitioners of medicine. The aim was, by giving due attention to the history of science, to bear witness that (German) scientists and physicians were not merely practitioners of professional specialities, but in Sudhoff's words, part of "the cultural work of mankind, of its greatest power".[343] The exhibition itself, as Sudhoff intimated, was a "selfless idea" that had remarkably taken hold among some meeting scientists in contradiction to the reigning conception of the materialism of the present age.[344] Contained in this assertion was Sudhoff's conviction that scientists, far from being the most inveterate of all materialists, were going to be increasingly represented by a faction that knew the worth of studies of the past—indeed, that these representatives could be counted on to show natural science and medicine's part in the historical unfolding of the human spirit just as convincingly as humanist intellectuals could do for their own endeavor.

Sudhoff claimed that the exhibition would hearten supporters of the history of science that there had been a new spur to their field.[345] He later concluded that the spirit of the exhibition was carried over into formation of the German Society for the History of Science in 1901, of which he was the first and long-serving head. In 1906 Bernhard Reber, a nearly unrivaled collector of historical pharmaceutical apparatus in Bern, Switzerland, called the 1898 exhibition

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[342] Ibid.: 1103.
[343] Sudhoff, *Historische Ausstellung Für Naturwissenschaft Und Medicin in Den Räumen Des Kunstgewerbe-Museums: Düsseldorf, Juli-October 1898 (70. Versammlung Deutscher Naturforscher Und Ärzte Zu Düsseldorf 1898)*, 10-11.
[344] Ibid., 5-6.
[345] Karl von Sudhoff, "Vorwort," in *Historische Ausstellung Für Naturwissenschaft Und Medicin in Den Räumen Des Kunstgewerbe-Museums: Düsseldorf, Juli-October 1898 (70. Versammlung Deutscher Naturforscher Und Ärzte Zu Düsseldorf 1898)*, ed. Karl von Sudhoff (Düsseldorf: August Bagel, 1898), 10.

a "great success", considering it as a "praiseworthy start" in the direction of the formation of full-scale medical museums, which he envisioned with archives and libraries.[346]

In its scope, the Düsseldorf meeting historical exhibition was the most extensive of the temporary historical exhibitions covered in this chapter. It was, as I have recounted, full of objects from eras and cultures distinctly non-Germanic. It thus expressed Germans' emerging interest in the whole extent of history of science, not merely the part of it that directly reflected on the past German scientific achievement. More important, as a key intermediary event towards the innovation in 1901 of the German Society for History of Science, it was a kind of pivot point, or acceleration strip, after which the institutionalization of the history of science in Germany assumed its most concrete expression with the founding of the German Society, and then of the Deutsches Museum. As with a number of other display events highlighted in the dissertation, individual initiative was central to bringing off its successful orchestration. Staged in the key gathering point of the German scientific community, it testified to a burgeoning interest among a select group of German *scientists* in the history of their professional pursuit. Finally, the Düsseldorf display took place on a large enough scale that its repute contributed to a wider awareness among the general German public of the relevance and intrigue of the history of science.

EXHIBITIONS INCORPORATING THE HISTORY OF TECHNOLOGY

Unsurprisingly, given the close association between industry and the economy in Germany and in some other advanced nations, organizers creating German exhibitions celebrated not only the history of science but also that of technology. What is less self-evident is that private

[346] Bernhard Reber, "Über Den Notwendigkeit Und Den Wert Von Sammlungen, Die Geschichte Der Medizin Betreffend," in *Verhandlungen Der Gesellschaft Deutscher Naturforscher Und Ärzte 78. Versammlung Zu Stuttgart 16.-22. September 1906*, ed. Albert Wangerin (F.C.W. Vogel, 1907), 93.

interests, not the German government, would have been the motivators behind some of these German initiatives. Though commercial or other considerations, therefore, had more to do with the mounting of these exhibitions than the regime's intentions did, the German participation at exhibitions of the history of science and technology showed national pride and assertion in every instance.

1881 PARIS INTERNATIONAL ELECTRICITY EXPOSITION

In 1881 a first International Electricity Exposition was held at Paris. This field of science, if any, would seem to have been one of *new* findings. The official catalogue expressed the sense of its forward momentum: "The international exposition of Electricity opens a new era in the history of science. It's the reign of Electricity that steps forward, alongside that of steam."[347] "Only several years ago it was scarcely a question of applications of Electricity. Today they appear on every side…They follow one another so quickly…that physicists can scarcely follow their progress."[348] Nevertheless, there was also an account taken here of earlier scientific findings, with a division maintained between the new apparatus and the apparatus belonging to a slightly earlier period. Or, as a contemporary account framed it, the presence at the exhibition of the historical items relating to electricity formed a baseline (*point de repère*) from which to gauge the progress in contemporary electrical science, and could be called a "retrospective museum".[349]

The German participant institutions (including the university scientific institutes, which were under governmental authority) and businesses loaned items to the Paris electrical exposition

[347] Anonymous, *L'électricité Et Ses Applications: Exposé Sommaire Et Notices Sur Les Différentes Classes De L'exposition* (Paris: A. Lahure, 1881), 174.
[348] Ibid.
[349] Henri de Parville, *L'électricité Et Ses Applications: Exposition De Paris* (Paris: Masson, 1882), 7 footnote 1.

in substantial numbers. This occurrence was interesting, among other things, for the fact that Germany had desisted from participation in the French 1878 World's Fair under the presumption that the two nations were still opposed in the aftermath of the 1870 Franco-Prussian War, and further would not participate at the French 1889 World's Fair because of the for the Germans unpleasing implications of its being France's celebration of the centenary of the French Revolution. But electrotechnology was an area in which Germany was particularly active, and electricity a major popular enthusiasm, perhaps making non-participation in 1881 seem a counter-productive decision for the nation. A further reason, unmistakably, was that while there was participation of government agencies in the German showing at Paris, the event did not involve the German government in an official representation of the nation, as was the case with participation at world's fairs.

The principal countries which the official catalogue singled out as the most active at the exhibition were "the United States, England, Germany and Belgium, which "offer[ed] visitors the diverse products of a science in complete development", while objects from Austria, Hungary, Italy, Russia, Switzerland, the Netherlands, Denmark, Norway, Sweden and Japan also appeared.[350]

In a report of the jury of the exposition published in 1883, its historical aspect was underscored. The jury wished to give its assessment

> especially [of] the retrospective displays whose principal aim was to reunite and appose to [more recent] applications the apparatus and the documents of all kinds having belonged to the founders of electrical science. The Exposition thus finds its roots in the past. All the successive discoveries that have transformed this science in one century unfurl before the visitors' eyes.[351]

[350] Anonymous, *L'électricité Et Ses Applications: Exposé Sommaire Et Notices Sur Les Différentes Classes De L'exposition*, 174.
[351] *Exposition Internationale D'électricité Paris 1881 Administration -- Jury Rapports*, 2 vols., vol. 2 (Paris: G. Masson, 1883).

The electricity exposition category devoted to old apparatus was denoted as the Retrospective section whose full title was the "Retrospective collection of apparatus concerning the initial experiments and the oldest applications of electricity." In fact, since the applications of electricity for practical functions belonged to the nineteenth century, it could be fairly said that of almost any science, electricity at that stage had a paucity of really old relics. Still, the decision to claim for its mainly decades-old items the status of "historical" shows this exhibition's continuation of the idea from 1876 that science's past deserved appreciation. It also showed an increasingly affirmative general orientation that remainders of past science, even those of recent vintage, contribute to the "feel" for what that science is and so should be part of a representation of it.

As with the 1876 exhibition, the likelihood of anything comparable being soon done again was discounted in the *French* proceedings:

> We must fully recognize here our state administrative agencies, universities and great scientific institutions for the generosity and the commitment they have shown to the retrospective exposition. It's been possible in this first electrical exposition to bring together the precious relics of the scholars of all nations—nothing makes it seem likely that so happy conditions will soon be reproduced.[352]

There were actually two sections of historical content, one being devoted to the apparatus and the other, bibliographical, being in part historical and having some items of truly venerable age.

An article in the *Elektrotechnische Zeitschrift*, the journal of the Association of German Electrotechnicians, concerning the exposition showed a mood of assertion in regard to science and a recognition that the past German scientific achievement further contributed to the new nation's luster.

> The Electrical Technical Society has…from the beginning in clear knowledge of the significance and importance which the exhibition and the [attendant] Congress also has for Germany, with full energy worked so that German electrotechnology and science

[352] Ibid., 83.

> would get a worthy representation, in order that the exhibition reflect the lively activity of Germany in the fields of pure and applied electrical learning and a justified recognition attach to the profuse outstanding German achievements in the past and present.[353]

The journal's report on the upcoming exhibition noted that an original intention of the Association to provide its own depiction of the historical development of German electrotechnology had been scotched because of the lack of time to get it ready. The German government did not attempt to remedy this deficit.

The historical exhibition incorporated history in two rooms (Rooms 18 and 20) out of some twenty-five. The French brought to the historical display an experimental table of Ampère, an electro-magnetic machine of Hippolyte Pixii, an electric apparatus of Victor Regnault among which was a thermo-electric couple, a differential galvanometer for the measurement of electrical resistance of Antoine-Cesar Becquerel, an apparatus of his son Edmund Becquerel, including an electro-magnet and a rheostat to measure the electrical resistance of gases and liquids, and an automatic regulator for electric arc light by Léon Foucault. Additionally from France, there were two original manuscripts of Ampère on electrodynamics, and autograph documents of François Arago, Michael Faraday, Macedonio Melloni and Ampère.[354] Clearly, the impressive collection of French-submitted historical electrical apparatus and related items predominated in the exhibition's historical component.

The German historical electrical apparatus was largely composed of nineteenth century telegraph-related devices and batteries, and even included evacuated tubes. The German Imperial Post Office sent several hundred items, including the materials relating to the technical development of German telegraphy and a model of the famous German physicist Otto von Guericke's first static electricity generator of 1663. The Post Office also sent a peculiar

[353] "Ausstellung Und Kongress in Paris Juli 1881 " *Elektrotechnische Zeitung* 2 (1881): 256.
[354] *Exposition Internationale D'électricité Paris 1881 Administration -- Jury Rapports*, 185-200.

demonstration device from the mid-nineteenth century called an electric egg, the term designating a tube largely evacuated in which an electrical discharge in the residual gas is stimulated through high voltage, and the electrochemical telegraph of Soemmerring already built in Germany in 1809. An exact copy of the German Philipp Reiss's telephone, which had been first presented in 1861—while Graham Bell, generally accorded recognition as the inventor of the telephone, had only developed a telephone in 1875—was on display, labeled with its date of invention, at the 1881 Paris exhibition, without an explicit claim for its priority. But assertions of priority in connection with the exhibitions of scientific apparatus could also be explicit, as when the *Elektrotechnische Zeitschrift* claimed in its report on the 1881 Paris electricity event that evacuated tubes producing luminescence were invented in Germany in 1869, preceding by a decade the date commonly attributed as that of their invention by the Briton William Crookes.[355] One German institution sent a collection of scientific books from the seventeenth and eighteenth centuries.[356]

A number of German governmental bodies made available exhibition items to the historical display, along with some university institutes and various business organizations. Among these were the Ministry of Public Works, the Senate-Commission for Imperial and Foreign Affairs, the Medical-surgical Friedrich Wilhelm Institute of Berlin, the Terrestrial Magnetic Observatory and Physical Institute of Göttingen University, the Royal Saxon Polytechnic of Dresden, and the Mathematical-physical Institute of University of Marburg. Businesses contributing to the historical display were the Thuringian Railroad and the Siemens Corporation. As appears both here and below, the firms Siemens and Halske, and Siemens itself, offered up their own past products for display at several of the display sites covered in the

[355] "Ausstellung Und Kongress in Paris Juli 1881 ": 256.
[356] *L'électricité Et Ses Applications: Exposé Sommaire Et Notices Sur Les Différentes Classes De L'exposition*, 70.

dissertation. The submission of many artifacts, themselves only at most a few decades old, to electrotechnology exhibitions and worlds fairs by a couple of the largest German electrotechnology firms is amplified in Iwan Morus's treatment of the commodification of electrical science in his *Frankenstein's Children*.[357]

With nineteen institutions and offices making their historical apparatus or books available to the Paris exhibition, the German showing was more than a nominal one, prefiguring a similar resort to the historical at the international electrical events held in Germany during the following decade. The German telegraph and postal administration also sent some employees to visit the Paris event, whereby they would be able to derive the maximum use from the gathered materials including an increased awareness of the historical German achievements.[358]

Taken together, the set of the historical apparatus exhibited at Paris at the Electricity Exposition was wide-ranging both in respect to the electrical science represented and to the countries included. Germany was one of a number of guest countries which sent noteworthy historical objects, and its contributions in this instance could not be ranged above that of its peers. It is worth noting that the future founder of the Deutsches Museum of the Masterworks of Natural Science, Oskar von Miller, traveled as a twenty-five year old engineer to Paris in order to view the international electrotechnological exhibition. Miller was given a release by his Bavarian governmental engineering workplace in order for him to report on it. The early intimations of his future historical projects, including two electricity exhibitions with a historical element, and foremost among them, his national museum of science, the Deutsches Museum, may have first

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[357] Iwan Morus, *Frankenstein's Children: Electricity, Exhibition, and Experiment in Early-Nineteenth Century London* (Princeton: Princeton University Press, 1998), 83.

[358] Ministère des Postes et des Télégraphes, *Exposition Internationale D'électricité, Paris, 1881 Catalogue Général Officiel, Commissariat Général* (Paris: A. Lahure, 1881), 257. See Anthony J. Turner, "Paris, Amsterdam, London: The Collecting, Trade and Display of Early Scientific Instruments, 1830–1930," in *Scientific Instruments: Originals and Imitations. The Mensing Collection, Proceedings of a Symposium, Held at the Museum Boerhaave, Leiden, 15-16 October 1999*, ed. Peter R. De Clercq (Leiden: Museum Boerhaave, 2000), 27 where Turner incorrectly states, based on this catalogue, that there were only about fifty retrospective display items and eleven exhibitors.

come to him as he saw the assemblage there of a vast number of science-related objects, including some historical ones, presented to the general public.

The Paris exposition brought electricity before the public in a way that it had never been before. The French organizers took the initiative to include a historical component, and the ensemble of the French artifacts was the most impressive of any country. What constituted the main impact in Germany of the exhibition was a further dissemination of a substantial public interest in historical scientific objects. It would soon be followed by the international electrical displays staged in Germany with a smattering of historical objects. The German historical participation at Paris and then at the two electricity displays in Germany illustrate that the sponsors of science in the new nation were alive to the relevance of featuring the history of science as part of the showing of German science's accomplishments that the new nation wished to lay claim to.

MUNICH ELECTRICITY EXHIBITION IN 1882

In Munich just a year after the Paris electrical exposition, Germany's first electricity exhibition was co-organized by Wilhelm von Beetz and by the future founder of the Deutsches Museum, Oskar von Miller. Fresh from his visit to the Paris exhibition, and excited to lead Germany into the electricity era, Miller was young, untried--and full of ideas of how an international exhibition could raise the German visibility in the area of science and technology. As in Paris, the Munich exhibition was in part devoted to the contemporary technology of lighting.

Although it was international, the Munich exhibition could not hope to rival the prior year's Electricity Exposition in Paris. This was not too surprising, for while France, in Paris,

already in 1881 had had the experience of mounting two world's fairs, Germany in 1882 had mounted neither world's fairs nor other international exhibitions of large scope. However, the exhibition featured one impressive novelty: the demonstration of the transmission of electrical power over long distances, in this case more than thirty miles. The amount of the power transmitted was two and a half kilowatts, a relatively small amount but one sufficient for operating an artificial waterfall.

The historical content at Munich was modest, certainly not up to the level of the host nation at Paris a year earlier. A series of historical German physical apparatus was displayed at the Munich event; of the participant nations, however, apparently the only submitted historical artifacts were from Germans. Miller later wrote that he had tried to make the exhibition a site for public edification, just as he was in subsequent years to make edification a priority at the Deutsches Museum. The display at Munich likely had a more limited influence on the network of the Germans (and others) whose interest in history of science was consolidated through such events than did some other displays covered here—electricity as a realm of science primarily connoted progress and the future. But the decision to include a historical dimension, as at Paris, indicated that the proponents of science in Germany increasingly saw this dimension as more than incidental.

Officially, the historical items were grouped with the contemporary *natural scientific* instruments. In the distribution of rooms, however, the floor plan showed a separate room with the title "Historical Division".[359] The combination of the historical items and the contemporary natural scientific instruments was one of twelve divisions. This division was supervised by three

[359] Oskar von Miller, "Erinnerungen an Die Internationale Elektrizitäts-Ausstellung Im Glaspalast Zu München Im Jahre 1882," *Abhandlungen und Berichte--Deutsches Museum* 4, no. 6 (1932).

professors.[360] The source of the greatest number of loaned historical items was "the rich collection of the Physical Cabinet of the Munich Technical College," whose director was Wilhelm Beetz, co-organizer of the exhibition.[361] The general management of the Bavarian Transportation Office, Division for Post and Telegraphs, displayed a series of historical telegraphs. The Conservatorium of the Royal Bavarian Mathematical-Physical Collections loaned the first convenient electromagnetic telegraph, by Carl August von Steinheil after the design of Gauss and Weber, as well as electrical clocks by Steinheil.[362] As at Paris the prior year, the telephone of Philipp Reis was presented. A member of the Soemmerring family in Frankfurt displayed not only Samuel Thomas von Soemmerrings's second gas-release, electrochemical telegraph (the whereabouts of the first had become unknown) but his alert mechanism and wire. Professor Carl von Voit of the Munich Physiological Institute exhibited old electrophysiological instruments.[363]

The intention of the historical dimension at Munich was, to a degree, pedagogical, allowing the visitors to trace the development of telegraphic apparatus. Its historical reach was limited, with apparently the earliest item being the second Soemmerring telegraph from the first decade of the nineteenth century. The second oldest original telegraph that was on display at the exhibition was Steinheil's magnetic telegraph of the late 1830s.[364]

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[360] Anonymous, "Internationale Elektrizitäts-Ausstellung Verbunden Mit Elektrotechnischen Versuch in München," *Elektrotechnische Zeitung* 3, no. 9 (1882): 323.
[361] Wilhelm Beetz, Oskar Miller, and Emmanuel Pfeiffer, *Offizieller Bericht Über Die Im Königlichen Glaspalaste Zu München 1882 Unter Dem Protektorate Sr. Majestät Des Königs Ludwig Ii. Von Bayern Stattgehabte Internationale Elektricitätsausstellung* (München: Autotypie Verlag, 1883), 50.
[362] Ibid., 148. Anonymous, "Internationale Elektrizitäts-Ausstellung Verbunden Mit Elektrotechnischen Versuch in München," 325.
[363] Anonymous, "Internationale Elektrizitäts-Ausstellung Verbunden Mit Elektrotechnischen Versuch in München," 355-56.
[364] Beetz, Miller, and Pfeiffer, *Offizieller Bericht Über Die Im Königlichen Glaspalaste Zu München 1882 Unter Dem Protektorate Sr. Majestät Des Königs Ludwig Ii. Von Bayern Stattgehabte Internationale Elektricitätsausstellung*, 148.

As at Paris the prior year, the historical electrical apparatus lent an additional gravity to the Munich display, demonstrating that the current practice of electricity had developed through stages. Because of the limited scope of the historical element, its presence had a symbolic quality, as if simply to assert that the technology's past should not be overlooked. Further, and importantly, the historical items, which were exclusively German, put forward in the visitors' minds the developments that had led to the current preeminence of German science and technology.

INTERNATIONAL ELECTRICAL EXHIBITION OF 1891 IN FRANKFURT

A modest effort in historical display emerged at another German-based international electricity exhibition, in Frankfurt nine years after the Munich exhibition, one that in its overall scope was more a counterpart to the Paris 1881 International Electricity Exposition than to the 1882 Munich exhibition. However modest its historical element, its presence showed that now science displays were now starting to routinely pay attention to it. But as a force in helping to build a network of supporters and practitioners of the *history* of science, the Frankfurt exhibition was limited. This is somewhat surprising, given that Oskar von Miller, the future founder of that great monument to past science—the Deutsches Museum—was the exhibition's co-organizer.

The Frankfurt exhibition was intended to present electricity as a force of progress, as had been done in Paris, through elaborate display techniques. The pretensions of the exhibition were substantial, though no high-ranking Imperial official visited the exhibition, indicating that official involvement was circumscribed.[365] A signal achievement at the exhibition was the demonstration of the transmission of power over more than one hundred miles using three-phase technology—the first time long-distance power transmission for a utility had been demonstrated.

[365] Jürgen Steen, *"Eine Neue Zeit ...!": Die Internationale Elektrotechnische Ausstellung 1891* (Frankfurt am Main: Historisches Museum, 1991), 282.

Miller, who had co-organized the Munich Electricity Exhibition of 1882, was the leading light behind the Frankfurt Electricity Exhibition. Miller had, between his organization of the Munich exhibition and that of the Frankfurt exhibition, served as a director of the German Edison Company.

It was primarily German, Swiss and Austrian electrotechnology that had substantial representation at the exhibition.[366] The mere handful of the electrical historical objects, for an exhibition which was intending to draw an attendance of six hundred thousand or more, did not pointedly direct the visitors' awareness to electricity's historical dimension. A contemporary German account is a register of some dissatisfaction with the historical element. It noted the absence of a number of "must-see" display items.[367] A retrospective account of the historical component speaks of the impression of a mixed bag (*Sammelsurium*) of items given by a photograph of the items on view in the Telegraphy and Telephony Hall, which had no explanatory materials.[368]

Philipp Reiss's telephone—the "first telephone" of 1861--was on display as it had been at the Paris Electricity Exhibition, but it was lodged among other items in an inconspicuous way.[369] The German railroad administration had a rather extensive display covering the complete history of railroad signaling—a very specific dimension of history to treat, and most all of the items in this display were manufactured by one company, Siemens & Halske. Images near the exhibition entrance of Goethe, telegraph inventor Soemmerring, and Heinrich Hertz alluded to Germany's continuing scientific cavalcade, but this was an understated presence for history.

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[366] Ibid., 20, 29.
[367] Anonymous, *The Electrician* 27, no. 681 (1891): 128.
[368] Steen, *"Eine Neue Zeit ...!": Die Internationale Elektrotechnische Ausstellung 1891*, 95.
[369] Ibid., 100.

Perhaps taking its cue from the 1881 Paris display, the German organizers chose to repeat that display's inclusion of the historical dimension. While at the three electricity displays the organizers did not press home Germany's national part in the historical dimension, the inclusion, however minimal, of that dimension was an acknowledgement that any presentation of science was informed and enlivened by some reference to its history. This willingness to include historical relics in displays was consistent with the German sense of the importance for the new nation's stature of being the heir to a great German tradition in science.

WORLDS FAIRS' GERMAN HISTORICAL SCIENTIFIC DISPLAYS

At two world's fairs around the turn of the century, Chicago in 1893 and St. Louis in 1904, as recounted below, Germans mounted significant historical scientific exhibits in America that included instruments or apparatus. In these events, the German government stood behind the effort to organize the exhibitions. Promotion of the national German interest was foremost in their preparation. As a side-effect, this promoting in part through reference to past scientific achievement also contributed to building a network, both among German visitors and others, of people devoted to the history of science. Between the Chicago and St. Louis World's Fairs, Germany prepared a minimal historical appearance in 1900 at the Paris World's Fair.

CHICAGO WORLD'S FAIR OF 1893

At Chicago in 1893, famed mathematician Felix Klein was the official representative appointed by the German government for its Universities Exhibition. This exhibition served to set forth the strong achievements of German higher education, and within this general theme, science received important attention. But more was aimed at; "[w]ith its universities exhibition,

the Empire of Kaiser Wilhelm used this occasion [Chicago World's Fair 1893] to place itself in the limelight as a leading cultural nation among world powers."[370] Its past and present scientific achievement had much to do with its ascertaining its current cultural precedence.

A group of German historical scientific objects was found in a Gauss-Weber display as a part of this exhibition. Within it were various types of instruments of these scientists' joint design for geomagnetic measurement and for telegraphy.[371] Gauss had been Director of the Göttingen University observatory between 1816 and 1855. Gauss and Weber were professors together at the university during two periods (Weber, a member of the university's Göttingen Seven group of protestors against royal Hanoverian overreach, was "exiled" from the university for an intervening period during which he was professor at Leipzig.) Handwritten and printed correspondence included three letters of Weber and one of Gauss.

The universities display gave significant additional emphasis on past German work in the natural sciences. There were, among old runs of journals, academy proceedings, and dissertations, those devoted to science. Recent, academy-edited volumes of the mathematical works of great past German mathematicians were also displayed. Within the chemistry retrospective of the German universities display, an assemblage of one thousand five hundred historically noteworthy chemicals were set forth in an outwardly scarcely appealing form, along with past issues of the German Chemical Society's house publication.[372]

The German Universities Exhibition included in its physics section a few select pieces of historical apparatus. One item was the seventeenth century Otto von Guericke air-pump. This relic was certainly prized, as attested to by its having been sent to the 1876 London Science

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[370] Michael Eckert, *Arnold Sommerfeld: Science, Life and Turbulent Times 1868-1951, Translated by Tom Artin* (New York: Springer, 2013), 29.
[371] O. Lassar, *Katalog Der Universitäts-Ausstellung Deutsche Unterrichts-Ausstellung in Chicago 1893* (Berlin: Trowitzsch & Sohn, 1893), 48-59.
[372] Vaupel, "Chemie Für Die Massen: Weltaustellungen Und Die Chemieabteilung Im Deutschen Museum," 49.

Exhibition. The physics section also had the spectrometer of Kirchhoff and an instrument for measuring the expansion of gases with increased heat of Gustav Magnus. The catalogue's physics section also mentioned other historical apparatus on display that was not specifically detailed, merely indicating that

> [i]t was decided at least a selection of (preferably original) apparatus to put on display, which owe their origination to German scholars or have served these scholars in their work and thereby can rate in the historical sense as characteristic or instructive for some important stages of the developmental history of Germany's physical research.[373]

It is interesting that the catalogue of scientific instruments of the German universities' exhibition in the 1904 St. Louis World's Fair, looking back at the historical element at Chicago in 1893, recited its also having included historically important apparatus apparatus of Helmholtz.[374] The Kirchhoff, Magnus and Helmholtz apparatus were of the very recent past, and allusion to them as authentic instrumentation helping to trace historical development of sciences because of their role in important discoveries shows foremost a German Empire appreciation of near-contemporary instruments. Their inclusion at the Universities Exhibition hints at a beginning interest in conservation of contemporary instruments used in crucial experiments.

Also part of the German Universities Exhibition at Chicago was a selection of paintings and busts of university scholars. It is remarkable that of the twenty of the busts, eleven were of German scientists, all of them active in the nineteenth century. Of the eleven scientists, five were physicists (Gauss, Wilhelm Weber, Kirchhoff, Neumann and Helmholtz), three were chemists (Liebig, Hofmann, and Kekulé), and one each were a geographer (Humboldt), a physiologist (Johannes Müller) and a physician/archaeologist (Virchow).[375] The bust of the great German

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[373] Lassar, *Katalog Der Universitäts-Ausstellung Deutsche Unterrichts-Ausstellung in Chicago 1893*, 81-82.
[374] *German Educational Exhibition World's Fair, St. Louis, 1904 Scientific Instruments [in English]*, (Berlin: W. Büxenstein, 1904), iii.
[375] Ministerium Für Wissenschaft Kunst und Volksbildung, ed. *German Educational Exhibition World's Fair, St. Louis, 1904: Scientific Instruments* (Berlin: W. Büxenstein, 1904), 7.

mathematician Gauss was “colossal”. Paintings of the mathematicians Jacobi, Dirichlet and Riemann also appeared.[376]

The German historical scientific objects at Chicago were not limited to the Universities Exhibition; three exhibitors lent historical objects which appeared as part of the German electrotechnology display: Charlottenburg Technical College, the *Postamt* (Imperial Post Office), and Siemens Corporation. Charlottenburg was represented with some electrical apparatus related to railroads. The *Postamt* contributed about fifteen instruments, primarily of telegraphy but with a couple relating to telephony, extending back in time to 1817. It also displayed a number of electrical devices relating to telegraphy invented by Werner von Siemens. These tied in nicely with the electrical apparatus displayed by the electrotechnology firm Siemens & Halske.

PARIS WORLD’S FAIR OF 1900

In 1900, at Paris, Germany participated at a French world’s fair for the first time since 1867, having stayed away from the French fairs in 1878 and 1889. The French had stipulated that there should be a look backwards in all sections of the fair at this changeover to the new century. In their chemistry section the *French* historical contribution was significant, featuring original apparatus of Antoine Lavoisier and other French chemists of note. The German historical chemical offering was confined to an effort of the German Chemical Society, and they were unable to do much better than they had in 1893, simply gathering together two hundred twenty chemicals first produced by Germans that had some industrial importance.[377] There had been

[376] Dyck, "Einleitung Zu Dem Für Den Mathematischen Teil Der Deutschen Universitätsausstellung Ausgegebenen Specialkatalog," 44.
[377] Vaupel, "Chemie Für Die Massen: Weltaustellungen Und Die Chemieabteilung Im Deutschen Museum," 50.

some discussion by German chemists about including historical apparatus but the decision was ultimately made to limit the scope of the presentation to the chemicals themselves.[378]

ST. LOUIS WORLD'S FAIR OF 1904

At the 1904 St. Louis World's Fair, German chemistry showed itself as a scientific powerhouse whose history was pronounced. The guiding intent of the historical display, staged as part of the thematic section of German Education, was to provide "the developmental history of German chemistry through a clear image of the inmost connection of theory and practice." The effect, a German commentator, Flury, maintained, was beyond what had been previously accomplished by any world's fair chemical display.[379]

In the guest room of the historical display, chests contained priceless works of old alchemy, assembled by a Munich bookseller. By the inclusion of their works in the exhibition, along with an alchemist's chamber, the organizers made plain that this period of German proto-chemistry was being claimed as noteworthy and vital. Flury imagined that the chemist Johann Friedrich Böttcher might have invented his porcelain in just such surroundings, and the invention of firing powder from saltpeter might have similarly taken place. Flury accorded great historical credit to the alchemist's chamber; its lifelikeness conjured the ancient adept, busy making epochal discoveries.[380] The alchemist's den was replete with the various implements used to do true chemical manipulations. Flury made a mention that this recreation was reminiscent of the comparable display found at the German National Museum. Distillation apparatus accompanied hearths. Long-necked cylinders, retorts, basins, and tubes were of "bizarre form".

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[378] "Die Weltausstellungen Vor Dem Ersten Weltkrieg Und Ihre Bedeutung Für Die Popularisierung Der Chemie," 82.
[379] Ferdinand Flury, "Die Chemische Industrie Auf Der Weltausstellung Zu St. Louis," *Die Chemische Industrie* 27 (1904): 602.
[380] Ibid.: 604.

Another display room represented the Liebig Laboratory as of 1835. Replicas of Liebig's original apparatus conveyed an impression of a facility bearing some similarity to a contemporary one, at least when compared to the alchemist's chamber. But, Flury noted, the impression was deceptive, for many of the common resources of a modern chemistry laboratory were absent from the ensemble. The visitors were thus encouraged to discern that wonderful discoveries had been, in Liebig's era, made with modest means, leading to a German school of chemistry from which the entire world had benefitted.[381]

In other display areas, "original apparatus" of the chemist brothers Victor and Lothar Meyer, and of physical chemist Wilhelm Ostwald and his school, along with apparatus created by the physicist Friedrich Kohlrausch to measure electrolytic conductivity, were all presented.[382] The use of the term "original apparatus" for the instruments of contemporary or near-contemporary German scientists showed an extension of historical importance already to their work, just as had been done at Chicago in 1893.

A collection of chemical works by very early chemists, brought together by a Munich antiquarian, lent additional historical interest to the display, reaching back to the beginning of the sixteenth century.[383] Finally, there were busts of Mitscherlich, Liebig, Wohler, Rose, Hofmann, and Kekulé, all of the nineteenth century, and medallions, statues and portraits of chemists. All these would also be included at the Deutsches Museum, which in part borrowed its concept of presenting history of chemistry from the St. Louis display.[384] Chemical preparations of the famous earlier nineteenth century chemists Eilhard Mitscherlich, Liebig, Wohler, and A.W. von

[381] Ibid.
[382] Ibid.: 603.
[383] Ibid.: 601.
[384] Vaupel, "Chemie Für Die Massen: Weltaustellungen Und Die Chemieabteilung Im Deutschen Museum," 51.

Hofmann, and of the slightly later Kekulé and Wilhelm Körner rounded out the historical exhibition, with an emphasis here on recent history.

There was not a counterpart to the old chemistry apparatus in the discipline of physics by Germans at the St. Louis World's Fair. The catalogue for German scientific instruments at the Fair argued that since at Chicago in 1893

> special weight was laid on showing apparatus of historical interest and original construction with which the German scientists had made important and, in part, memorable advances in the exact sciences… [i]n preparing the present exhibit, it seemed clear that in the line of physics and related departments no stress should be laid on the historical side, to prevent a repetition of what was shown in Chicago.[385]

The World's Fairs were a significant showplace for history of science for the German Empire. They provided the means to demonstrate to international audiences that Germans were a people of science. The large role of history in German life was one factor giving rise to the nation's interest in showing off its scientific roots. Additionally, the history of science was becoming a force to conjure with, and the Germans were taking advantage of the world-stage at Chicago and St. Louis to bolster its international stature.

OTHER TEMPORARY DISPLAYS

COLOGNE EXHIBITION OF 1894 ON GERARDUS MERCATOR

There was a small but revealing historical scientific exhibition in Cologne in 1894. As sketched in the dissertation's introduction, it was exclusively devoted to Gerardus Mercator on the occasion of the three hundredth anniversary of his death. The Cologne city library, which prepared the exhibition, had discovered three major Gerardus Mercator publications among its holdings, long after two of these three, which had been for years been known only from

[385] *German Educational Exhibition World's Fair, St. Louis, 1904 Scientific Instruments [in English]*, iii.

references, were doubted to still exist, while the third was a famous world atlas of which the Paris national library held what had previously been believed the only extant exemplar.

Mercator was born in, and later received his high school and university education in Flanders, part of today's Belgium. The introduction to the Cologne exhibition's catalogue made pains to push the right to claim Mercator for Germany, and also to make clear his close links to Cologne. It called Mercator a "fellow-countryman", underlining that Mercator's birth in Flemish territory was fortuitous since his family was merely on a visit at the time. The introduction to the Mercator display catalogue claimed that his real development as a scientist, and the issuance of all his most venerated works, only happened once he was in Duisburg. The account fails to indicate that Mercator's secondary and university education were in Flemish territory and that there was a twenty year interval *after* Mercator got his university degree during which he remained and worked in the Flemish city of Louvain, including working for a time with the world-renowned Flemish globe- and map-maker Gemma Frisius and making two globes there.

That German claims for Mercator's nationality were not supported by Belgium was made clear by the erection in 1871 of a statue to Mercator at the Belgian town of Rupelmonde, and the same dissent from Mercator's German nationality can be seen for example at the 1895 Sixth International Geographical Congress at London, where a reduced model of the Rupelmonde memorial was exhibited by Belgium along with a facsimile replica of a Mercator map, photographic reproductions of two of his globes, and two books about him.[386]

The particulars of the Cologne exhibit are not difficult to encompass, for there were thirty-five items, a number dating within the late sixteenth and early seventeenth centuries. Seven were maps and atlases of Gerardus Mercator actually published by him or his sons. Of the

[386] Anonymous, *Report of the Sixth International Geographical Congress (London, 1895)* (London: J. Murray, 1896), 40-46 in Appendix B -- Catalogue of the Exhibition.

maps and descriptive texts, each of his three sons did one. There was a specific, eventful connection shown between the city of Cologne and Mercator father and sons. In a work done by one of Mercator's sons were inserted pages of Gerardus's text of mathematical geography that he wrote for use in teaching at the Duisburg gymnasium (located near Cologne).

The exhibition showed eight Gerardus Mercator maps or atlases published by Jodocus Hondius of Amsterdam or his son Henricus.[387] There were also items whose presence at the exhibition was due to their containing the iconography of Gerardus Mercator: Rounding out the exhibition were thirteen scholarly books and articles on the origins of cartography or specifically on Gerardus Mercator. The introduction to the catalogue, written by A. Keysser of the Cologne city library, identified that the objects came not only from that library, but also from the Royal Library of Berlin, the Duisburg gymnasium library, the Imperial University and Provincial Library in Strasbourg, and a private collector.

Primarily, then, this display was an assertion of Germany's national prominence. In connection with Mercator, and other scientists, for whom German lineage was claimed in the nineteenth century, we see revealed the symbolic value of past scientific achievement for Germans in the nineteenth century. The Mercator exhibition was a small jewel of an example of such German ambition. Considering it in the light of Sam Alberti's idea of the lives of display objects in section 0.1.3. above, the Mercator display items were somewhat orphaned in being so few, but their "personality" was larger than their number suggests: there were two exemplars which were long believed to have disappeared and a third known in only one additional copy, and the assertion in the catalogue that Mercator should be considered a German added an ideological element to those items, reinforced by their being on display at a site in Germany.

[387] Adolf Keysser, *Katalog Einer Mercator-Ausstellung Im Lesesaale Der Koelner Stadtbibliothek* (Cologne: Druckerei der Kölner Verlags-Anstalt und Druckerei, 1894), 7.

Ranging from the small scope of the Mercator display to the huge span of the Deutsches Museum, displays and exhibitions gave the German nation the opportunity to reinforce to Germans and non-Germans the German standing in the world of science and in the world generally.

THE 1899 BAVARIAN COURT- AND REALM-LIBRARY EXHIBITION OF MEDICAL MANUSCRIPTS

The Bavarian Court- and Realm-Library, a historic Germanic institution whose origins reached back to 1558 (since 1919 called the Bavarian State Library) organized a modest and restricted exhibition in conjunction with the 1899 Scientists and Physicians meeting in Munich but organized separately from it. With its rich collections, among them 980,000 books, the library was in a position to offer a display of some select rarities, its "most beautiful and its best". The library's manuscript collection had not been previously properly annotated, so the projected display was a good chance to go through the manuscripts and produce a handlist.[388]

The display ran for two weeks. The first week was timed to coincide with the Scientists and Physicians meeting. But it was also open a second week, when presumably the public would have had additional time to view it.[389] The display was organized by the later Würzburg University philologist Franz Boll and the medieval manuscript expert Erich Petzet, both at that time in the library's manuscript division, Boll serving as its head. Boll had written on early

[388] Robert Fuchs, "Ausstellung Medicinischer Handschriften Und Autographen," *Wochenschrift für klassiche Philologie* 45 (1899): 1246.
[389] Anonymous, *Ausstellung Medicinischer Handschriften Und Autographen Im Fürstensaale Der Königlichen Hof- Und Staatsbibliothek* (Munich: Akademischen Buchdruckerei von F. Straub, 1899), 1.

astronomy, astrology and cartography. A tour of the Munich display, led by Boll, is documented.[390]

The Court- and Realm-Library did not need to go outside for loans as it already had the materials presented in the display within its collection. As the printed list of display items indicated, a larger portion of the library's general exhibition of manuscripts, miniatures, autographs and maps were all housed in the same room as the specially selected display, allowing a wider examination of materials than those culled for the display. If researchers wished, they were also granted permission to look through a selection of books on the history of medicine from the library's collection.[391]

Divided by medical specialty, the display manuscripts extended back in time as far as the ninth century, in the Latin text of Dioscorides (first century A.D. Greek physician), the subject of a presentation during the Scientists and Physicians meeting. A number of manuscripts were written in German. The preponderance were written in Latin, including several translated from Arabic, but there were some exemplars written in Italian, several in particular from the venerable medical school of Salerno. Of the latter, there was also one thirteenth century middle-German translation that served as "the foundation of all later German medicaments books".[392] There were partial texts from several seventh and eighth century manuscripts. Arabic texts went back as far as the eleventh century, with some containing drawings. Along with a couple texts in Persian and Ethiopian, the display contained a set of manuscripts written in Hebrew, some of them translations from Arabic. Another few texts were written in Greek and stemmed from the fourteenth through sixteenth centuries. There were examples of texts treating astrology's

[390] Albert Wangerin, *Verhandlungen Der Gesellschaft Deutscher Naturforscher Und Ärzte 71. Versammlung Zu München 17.-23. September 1899*, vol. 1 (München: F.C.W. Vogel, 1899), 631.
[391] Anonymous, *Ausstellung Medicinischer Handschriften Und Autographen Im Fürstensaale Der Königlichen Hof- Und Staatsbibliothek*, 2.
[392] Ibid., 8.

relationship to medicine and texts of alchemical-medical teachings. Overall, the slant of the collection seems to have been towards the curious and the rare, irrespective of national origins.

The library would have chiefly aimed through its temporary display to show Munich as a learning-loving, culturally-endowed center, to show its civic commitments, and to serve a group of scientists and physicians with particular historical/bibliophilic interests. As was the case in the larger historical scientific exhibition at the 1898 Düsseldorf Scientists and Physicians meeting, the nature of the display items, as much as those of any other display covered here, revealed the extent of German interest in the field of history of science of all eras. Historical interests typified the Germans of the Empire, now including their burgeoning fascination with science's, including medicine's, history. And although this display was not among those whose focus was primarily German artifacts, it helped to extend the network in Germany of scientists aware of the rich past of science, and even to build up the cadre of non-practitioners exposed to scientific relics.

THE INTERNATIONAL AIRCRAFT EXHIBITION OF 1909 HISTORICAL DIVISION

In 1909 in Frankfurt, the first international exhibition of aircraft was held. A historical display comprising primarily images and books was part of the three-month overall exhibition program. Both the historical flight division of the Frankfurt exhibition and the 1908 initiation of the contemporaneous *Deutsche Museum*'s Flight Division were premised on the great attention attaching to manned motorized flight accomplished for the first time just six (or eight) years prior, in 1903 (or 1901) by the Wright Brothers (or as Gustave Weisskopf, a German immigrant to the United States, claimed, by himself two years earlier). German interest in past aeronautics was not here limited to the feats performed by the Germans. Nevertheless, the Germans did have

their airborne heroes, both from the balloon era and in the immediate period before motorized flight, with the glider designer and pilot Otto Lilienthal.

Two organizers divided the responsibility for the historical division between them: Louis Liebmann of the Frankfurt City Library solicited and arranged images, while Gustav Wahl, the librarian of the Senckenberg Library of Frankfurt, did the same for books. The organizers sent appeals to newspapers, and circular letters to libraries, museums, archives, flying associations, collectors, antiquaries, and art dealers, requesting loans. There were a hundred forty-six exhibitors, with forty-eight libraries, museums, archives and city administrations contributing.[393] Altogether, besides German lenders, there were items from England, France, the Netherlands, Italy, Austria, and Switzerland. The Senckenberg Library staff was responsible for logistics and organization.[394] The organizers felt that "systematic order" of the organization of the display was crucial, along with "the most extensive set" of materials.[395] They proudly proclaimed that the historical division generated a healthy response by both experts and the press.[396] Over the nearly three months that the historical display was open, there were 231,000 exhibition visitors.[397] There was no admission fee for entrance to the exhibition including its historical display.

The historical display was mounted in a large room of the Frankfurt Festival Hall. To accommodate more items, partitions were set up creating four areas with walls on which the display's images could be placed.[398] Books were shown in glass cabinets. A notable feature of the historical division was the dedication of a separate room to the purpose of closer scientific study by researchers of the objects assembled.

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[393] Louis Liebmann and Gustav Wahl, *Katalog Der Historischen Abteilung Der Ersten Internationalen Luftschiffahrts-Ausstellung (Ila) Zu Frankfurt A. M. 1909* (Frankfurt am Main: Wüsten, 1912), xii.
[394] Ibid., xii-xiii.
[395] Ibid., xi.
[396] Ibid., iv.
[397] Ibid., xiii.
[398] Ibid., xii.

The section of historical books included an array of categories, with even some addressing flight in animals and plants. In the other section of the historical division, all the various apparatus used in attempts to ascend or glide, whether or not with people aboard, were present: balloons, kites, airships and winged vehicles were all represented. Materials included many of a cultural historical nature. The artifacts and images comprised, along with the portraits, all manner of objects with an iconography relating to flight: tableaux, fantastic images, medals, balloon flags, golf greens' flags, lacquered boxes, shooting targets, and decorative plates.

A forty pfennig outline of the historical display was available to visitors. However, it was not until 1912 that the complete guide was printed; Liebmann and Wahl were its editors. This full guide was meant to be a reference work and divided its subject into categories. Alongside the register of objects in the display, there was also a register of the persons associated with flight of any kind.

Of the sources of inspiration for this display's historical division, like for the Bavarian Court- and Realm-Library Exhibition at the Munich Scientists and Physicians meeting in 1899, a general attraction for history must be numbered first, with the urgent sense that displays delving into science and technology should now incorporate some of their history. But the German element among the display items was evident as well and served to promote feelings of national pride.

As a result of the frequency with which they encountered the historical dimension at displays, more Germans were now regularly paying attention to it and particularly to the German scientific past. As indicated throughout this chapter, the building of a network, achieved partly through participation and through attendance at displays, especially as it was in some cases both Germans and foreigners who were the primary intended audience of displays at home and

abroad, constituted an essential component of early institutionalization of the discipline of history of science. We now proceed to the second category of displays—or as I will refer to them, exhibitions—those at museums.

CHAPTER III:
PERMANENT HISTORICAL SCIENTIFIC EXHIBITIONS

This chapter details the permanent exhibitions on the history of science during the German Empire which German organizers either participated in or hosted. Some were particularly significant sites attesting to the importance in reinforcing national stature being attached to the German people's standing in science in past eras as well as in the present. Of the multiple dimensions of activity commemorating the past of science, exhibitions were eloquent in attesting to the German Empire initiative in giving a new prominence to it. The main points of the chapter are that the number of newly instituted permanent exhibition sites during the German Empire with a component of the history of science outstripped those of earlier comparable periods, that for the first time two museums of national scope brought scientific relics before the public, that in addition to these, a number of more specialized sites also performed this office in the same period, and that while there had previously been various permanent sites that held scientific relics, few of these had been, or had been widely known to be, open to the general public. Sources consulted for this chapter include the archived internal documents of the Deutsches Museum, house publications of the sites, contemporary journal articles, histories of the sites, reports on world's fairs, published accounts of society meetings, an archived letter, and published speeches.

GERMANISCHES NATIONALMUSEUM

The German National Museum got its start in 1852 in Nuremberg, and soon became a very important site for German memory, specifically of the Middle Ages. As one contribution in a recent conference on museums as sites of national identity notes of the period, "[t]he breakup

of old social structures called for the creation of symbolic markers of the national identity appealing to the masses," and the new Nuremberg institution was a powerful instance of gathering German sentiment in this direction.[399] During the period of the German Empire, among its various units, the museum formed three devoted to aspects of science, and these manifestations of the German organizers' pride in past German science impressed the citizens all the more because they were part of a national institution, contributing to the formation of a network of people giving attention to the history of science.

Soon after the museum's founding as a "Germanic Museum" in 1852, its founder, Hans von und zu Aufsess, declared its success: "Here is an all-sided well-wishing participation of all German social layers and classes, expressing its stamp of largeness of purpose and national character."[400] The year after the museum's founding, the German Federal Assembly at Frankfurt recognized it as a "national" institution, from which point the museum began to be referred to as the German *National* Museum, and giving it a stature as national must have significantly raised the prospects for its public and private support.[401] Before the German unification, the governments of Prussia and Bavaria gave financial contributions to it, and after unification, beginning in 1874 the Imperial budget included the grants that aided it to expand its physical footprint.[402]

The museum's concentration on the Middle Ages and Renaissance periods was in the service of constructing an image for the Germans of past times when they as a people had been

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[399] Constanze Breuer and Paul Kahl, National Museums as Memorial Places: The Goethehaus Weimar and the Foundation of National Museums in 19th Century Germany, (Paris: Linköping University Electronic Press, 2012), http://www.ep.liu.se/ecp/078/ecp11078.pdf. 92.
[400] Citation from GNM Jahresbericht 3 (1856) in Bernward Deneke and Rainer Kahsnitz, *Das Germanische Nationalmuseum, Nurnberg 1852-1977: Beitrãge Zu Seiner Geschichte* (Munich: Deutscher Kunstverlag, 1978), 145.
[401] Frank Matthias Kammel, The Germanisches Nationalmuseum in Nuremberg: The Cultural Memory of a Nation without National Borders (Paris: Linköping University Electronic Press, 2012), http://www.ep.liu.se/ecp/078/014/ecp12078014.pdf. 218.
[402] Ibid.). 221.

avowedly great. In the words of another contribution to the conference just referred to on museums and national identity, the German National Museum tasked itself with "seek[ing] out relics of the past providing cultural-historical testimonies to the cultural conditions of life, in order to consider the question of what united the Germans as Germans."[403]

SCIENCE DIVISION

One year after the 1876 London exhibition, the German National Museum decided to consolidate its science items into a museum division. And Nuremberg, already the site of the museum for almost twenty-five years, was a location particularly suited to bring out the German contributions to science. In the words of a contemporary, "[t]ill the discovery of America and for a century after it, Nuremberg had…taken the lead in Germany in all industrial arts."[404] Another contemporary wrote, "Nuremberg exerted, especially at the times of its efflorescence in the Middle Ages, a strong pull on all the men of science, and in the citizens themselves of Nuremberg lived a lively interest in the investigation of the secrets of Nature…"[405] The elevation of early science at a central site of memory in Nuremberg thus reflected and could help to heighten German, as well as local Nuremberg, pride in their scientific pasts. As Max Emmerich, a Nuremberg anatomist, proclaimed at the 1899 Scientists and Physicians meeting, "The German

[403] Ibid.). 219.
[404] Otto N. Witt, ed. *Columbische Weltausstellung in Chicago: Amtlicher Katalog Der Ausstellung Des Deutschen Reiches* (Berlin: Reichsdruckerei, 1893), 202.
[405] Wilhelm Beckh, "Beiträge Zur Geschichte Der Pflege Der Naturwissenschaften Und Der Medizin in Nurnberg: Einleitung " in *Nürnberg: Festschrift, Dargeboten Den Mitgliedern Und Teilnehmern Der 65. Versammlung Der Gesellschaft Deutscher Naturforscher Und Ärzte Vom Stadtmagistrate Nürnberg*, ed. Wilhelm Beckh (Nürnberg: Schrag, 1892), 1.

[National] Museum in Nuremberg forms…a central point, in which the entire historical development of German culture in all directions has been ordered and made visible."[406]

In keeping with the museum's unifying intentions, August von Essenwein, its director since the mid 1860s, "resorted to all circles of our [German] people" for their support. The Germanisches Nationalmuseum became "not only a memorial for Germany's past, but for the sacrifice and generosity of the German nation—it is not the endowment of a few, but has developed to its present blooming through the host of the small contributions of the whole people."[407] In the early 1890s the émigré apothecaries' newspaper issued in the United States, *Pharmaceutische Rundschau*, affirmed, "In the more than half century history of the museum the ideal characteristics of the German essence and of German constancy are emphatically expressed."[408]

Essenwein asserted that it was "dedicated to the history of all Germany [Germanic culture] and intended not only to gather and protect [material remains], but also through [scholarly] scientific work to make accessible to the most general use everything important for the knowledge of German early time [*Vorzeit*]…"[409] Essenwein wanted to create systematically conceived and arranged collections rather than stray objects; he sought to bring to the Germanisches Nationalmuseum continuous series of objects.[410] Not only should the museum be alluring, but its aims were also didactic. In this, the museum's exhibition philosophy was in keeping with that of a number of other German exhibitions, both temporary and permanent. His

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[406] Max Emmerich, "Anregung Zur Schaffung Eines Museums Der Heilkunde Für Das Germanische Museum in Nürnberg," in *Verhandlungen Der Gesellschaft Deutscher Naturforscher Und Ärzte 71. Versammlung Zu München 17.-23. September 1899 2. Teil 2. Hälfte*, ed. Albert Wangerin (Leipzig: F.C.W. Vogel, 1900), 130.
[407] Bösch, "Germanisches Nationalmuseum," 443.
[408] Anonymous, *Pharmaceutisches Rundschau* 9, no. 12 (1891): 283-84.
[409] Deneke and Kahsnitz, *Das Germanische Nationalmuseum, Nurnberg 1852-1977: Beitrãge Zu Seiner Geschichte*, 128.
[410] Hochreiter, *Vom Musentempel Zum Lernort: Zur Sozialgeschichte Deutscher Museen 1800-1914*, 85.

choice of head of the science division, Siegmund Günther, was well aware of the interest and significance of the developmental course of instrument design.

The science holdings of the museum began very modestly. As the museum had first opened, most scientific artifacts had their place within the category Heavenly and Earthly Knowledge, along with artifacts used to assist with surgery and child-bearing. By the mid-1850s, its holdings of scientific items consisted of only a single glass case with a mix of astronomical, astrological and alchemical objects.[411] Therefore, a change of some significance was signaled when in 1871the city of Nuremberg, through its magistrate, placed at the museum's disposal physical and other scientific apparatus formerly held by the neighboring, now-defunct University of Altdorf that had more recently been in the Nuremberg School of Commerce.[412] In 1872 the museum's house publication announced that the museum had acquired optical, astronomical, physical, and chemical apparatus, globes, atlases and other scientific apparatus dating from the end of the seventeenth and beginning of the eighteenth century, maintained in their original glass cabinets.[413] Loans made by Nuremberg institutions, and then by the city library, with rare items from the fourteenth and fifteenth centuries, introduced a small but important additional stock of scientific items.

A railroad car full of outdated physical science objects was sent in 1875 by the physics professor Friedrich Kohlrausch at Würzburg University.[414] Also, by the 1878 account of Siegmund Günther, the museum's map section and library contained a good amount of holdings of a scientific character, which was unlikely to have been acquired solely during the year since

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[411] Johannes Willers, "Wissenschaftliche Instrumente," in *Das Germanische Nationalmuseum, Nurnberg 1852-1977: Beitrãge Zu Seiner Geschichte*, ed. Bernward Deneke and Rainer Kahsnitz (Munich: Deutscher Kunstverlag, 1978).
[412] Anonymous, "Chronik Des Germanischen Museums," *Anzeiger für Kunde der deutschen Vorzeit* 18 (Neue Folge), no. 7 Beilage (1871): 210.
[413] "Chronik Des Germanischen Museums," *Anzeiger für Kunde der deutschen Vorzeit* 19 (Neue Folge), no. 4 Beilage (1872): 129.
[414] David Cahan, "The Institutional Revolution in German Physics 1865-1914 " *Historical Studies in the Physical Sciences* 15, no. 2 (1985): 13.

Günther had taken over directing the science division.[415] All of this suggests that there was a more than nominal amount of scientific material in the museum before 1877, some "from private ownership or from teaching collections of disbanded schools", but that it had not previously been suitably arranged.[416]

Günther gave the museum leadership credit for deciding to recognize science as an important part of Germany's cultural life through opening a science division.[417] He was disposed to feature some items for their cultural historical interest. He was attentive to the adornments and delicate fashioning of various instruments. For as he noted, they served admirably to show, through their elegance, a characteristic feature of the Renaissance that continued up through the eighteenth century: the close relationship between scientific instruments and the luxury trade.

In his 1878 report, Günther wrote regarding the character of the Germanisches Nationalmuseum scientific division's displays. At the scientific division's opening in 1877, the museum held two copper globes, beautiful and functional, fashioned by the sixteenth century geometer Johannes Praetorius. Another item remarkable for its age was a brass geometric quadrant from the fifteenth century, which was definitely of the school of the Viennese mathematician Georg von Peuerbach, famed researcher and teacher of the great fifteenth century scientist Regiomontanus, and which was "of the most decisive influence for the promotion of pure mathematics." There was a collection of telescopes and burning mirrors (for generating high temperatures.) One of the burning mirrors Günther identified as having been made "in the time of and in the environment of German inventor Walther von Tschirnhaus"[418], and possibly by Tschirnhaus himself—known for his exemplary burning mirrors as well as for putatively having

[415] Günther: 110.
[416]Ibid.: 93.
[417] Ibid.: 110.
[418] Ibid.: 94.

invented the porcelain-making process. Günther seemed already this early in his career to have the necessary scholarly background to make a stab at determining such distinctions.

Items of sympathetic healing, such as amulets, were to become part of the museum's scientific division that Günther was organizing. Their inclusion demonstrated that the museum saw no reason, in its largely Middle Ages-centered presentation of Germanic relics, to confine itself to the *present-day* conceptions of the scientific in representing science in its broadest possible sense (supposed or actual power over nature) in relation to cultural life.[419] Perhaps surprisingly, organizers at a number of display sites were not averse to the inclusion of amulets, symbolic formulas, and other conjurations representing earlier human attempts to deal with an uncertain world and influence the quality of life and power over nature, which later had their counterparts in scientific apparatus. The frequency of the display of these dim precursors of natural science suggests that organizers at times capitalized on the lure of the bizarre. Amulets and invocational scripts appeared in the Germanisches Nationalmuseum's scientific division and its Central Pharmaceutical Museum, the 1898 Düsseldorf exhibition, and the Kaiserin Friedrich-Haus display, showing off, from a cultural-historical standpoint, alien, and intriguing, objects. At the Pharmaceutical Central Museum, early pharmacists' offices with curious objects assembled there by tradition were reconstructed. Forbearance for such past peculiarities by professional groups such as chemists and pharmacists may have come from a sense that the present scientific enterprise was securely founded in rigorous thinking, while these older artifacts, forms of conjuring, demonstrated the duration of the German civilization.

The museum's conservation interests were apparent from the fact that the museum purchased an astronomical clock (which gave through its dials and moving plates information on the movements of heavenly bodies) from a private citizen in 1877 as a heap of disassembled

[419] Ibid.

parts, missing nearly the entire transmission. One district geometer in Schwabach who had already been of service to the museum multiple times was able to restore it.[420]

In 1883, the yearly report of the museum in its journal elaborated that "[t]here is still much to do before every museum division is not a conglomerate of more or less interesting things, but comprises a scientific whole."[421] He was candid enough to acknowledge the difficulties in not having available expertise in some areas that would yield a more perfect exhibition. Siegmund Günther thus may by this time already have ceased to be an agent in the regular operation of the museum.

Despite the definite unavailability of Günther from 1886, when he relocated to Munich, in 1893 he brought the science division's mathematical instruments some new prominence in a talk he gave at the Scientists and Physicians meeting held at Nuremberg. Undoubtedly reflecting the acquisitions made by the museum since he had ceased heading up the scientific division, Günther spoke of the good representation of large quadrants and sextants, used in navigation for charting direction, from the early 1700s. The museum's most richly exampled types were sundials, globes, maps, and early electrical apparatus. Maps were in plentiful supply covering early as well as later periods.

Günther's considered that scientists themselves should become more aware of those artifacts still extant. In a session of the 1907 meeting of the German Scientists and Physicians serving as the annual meeting of the German Society for the History of Medicine and the Natural Sciences, he announced that the Society would welcome it if participants of future Scientists and Physicians meetings would, where possible, bring historical scientific objects of a many-sided

[420] Ibid.: 108-09.
[421] Anonymous, "Neunundzwanzigster Jahresbericht Des Germanischen Nationalmuseums," 32.

interest that could be presented in the General Sessions (*allgemeinen Gruppen*) and Division Sessions (*Hauptgruppen*) to all participants.[422]

In 1911 the Germanisches Nationalmuseum made a significant addition to its holdings, purchasing four late sixteenth century instruments by the illustrious Prague German artisan Erasmus Habermel, which had been auctioned in Amsterdam. It previously had acquired three sun dials by Habermel.[423] Together with the instruments made by Praetorius that it already had, the museum now possessed, within its set of instruments, early exemplars remarkable for their skill of execution and their ornament, and globes extending back in time to the fifteenth century.

PHARMACY DIVISION

The interest in bringing about a pharmaceutical history site within the museum arose in the 1880s, almost certainly as an outgrowth of the Apothecaries' 1879 exhibition, since the originator of the idea, Hermann Peters, had previously been the assistant of Emil Prollius during the period when the latter headed up the 1879 apothecaries' exhibition. Hermann Peters was in the 1880s the owner of an operating historic apothecary's shop, the Moors' Pharmacy (*Mohrenapotheke*), in Nuremberg and a budding scholar of pharmacy. Thus, given Peters's interest in providing a public site for the historical study of pharmacy, the Germanisches Nationalmuseum was close at hand to be drawn into the project. The Pharmacy Division became the second of the museum's sites to put scientific objects on view for visitors, drawing them into the network of people aware of the German, and to some extent the broader, scientific past.

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[422] Albert Wangerin, ed. *Verhandlungen Gesellschaft Deutscher Naturforscher Und Ärzte 79. Versammlung Zu Dresden 15.-21. September 1907 Medicinische Abtheilungen*, vol. Zweiter Theil, II. Hälfte (Leipzig: F.C.W. Vogel, 1908), 422.
[423] Anonymous, "Zuwachs Der Sammlungen. Kunst- Und Kulturgeschichtliche Sammlungen," *Anzeiger des Germanischen Nationalmuseums* 4 (1911): 75-80.

Peters, after consulting the leading German pharmacists, proposed to Director Essenwein at the museum that the Society of Pharmacists take the lead in forming and maintaining a museum division on pharmacy. It opened in 1883. Behind Peters were thus the resources of a professional group, committed to forming and maintaining the display. The new unit was often referred to as the Central Museum of Pharmacy. Since it formed part of a national museum, it too, along with the science division, communicated some sense of Germany's scientific roots to the many citizens who visited the museum.

Just as with the opening of the museum's science division, the pharmaceutical objects already held by the museum and previously disparately displayed were culled in the service of the new pharmaceutical division. One part of the agreement made between the museum and the pharmacists' profession, before work had actually begun on the division, noted:

> The historical-pharmaceutical central-museum should be as far as possible a complete collection of original objects and of documents of the history of German pharmacy & medicine in bond with what may become necessary copies and models, as well as of comprehensive allied literature, and will through generally accessible display and through publications be made as broadly useful as possible.[424]

The conception at this time of the new section was that it would serve twin purposes: public instruction and specialist scholarship. Peters's own book *Aus pharmazeutischer Vorzeit in Bild und Wort* (*From Pharmacy's Past in Image and Word*), first published in 1886 and amended for subsequent editions, drew, as one review appraised, "[f]rom the exceptionally rich materials of the literary treasures of the Germanisches Nationalmuseum…"[425]

The new Germanisches Nationalmuseum division would serve the desire for scientific roots for the pharmacists' profession embodied earlier in a temporary exhibition at the German Society of Pharmacists in 1879 (see previous chapter). The national organization of pharmacists

[424] *Anzeiger des germanischen Museums* 2, no. 3 (1887): 34.
[425] "Literarisches," *Pharmaceutische Rundschau* 9, no. 2 (1891): 51.

successfully imposed on individual pharmacists to send in as donations the historical items they possessed. A glance through the museum's publication *Anzeiger* conveys that fairly regular contributions, not only of cash pledged by individuals and businesses, but also of apparatus, symbolic and commemorative objects and books relating to pharmacy were made throughout the period before the start of the first world war. Most common were the donations of old published works in German relating to pharmacy.

One idea was to situate, within the Germanisches Nationalmuseum's premises, a replica of an historic apothecary's shop. This would include typical rooms with old cabinetries supplemented with such objects illustrated in Middle Ages' books as pharmacists' boxes, jugs, jars, and oil candles. Other artifacts of interest would be a file with old druggists' recipes, books that early apothecaries would have consulted, and perhaps certificatory documents, contracts, official permits, regulations on drugs, grants of monopolies, and drug lists, catalogues and inventories. A 1915 written account by the pharmacy historian Hermann Schelenz touted the reconstructed shop at the museum as being "as is well known the first, most complete, historical apothecary's premises" (*historische Apotheke*).[426] His remark signified pride among the German pharmacists in the early origin of German pharmacy, in their nation, and in what had been accomplished by the profession at the Central Museum in that past's celebration.

Museum Director Essenwein was able in 1888 to attest that the museum library had numerous works already on alchemy, herbal books, and medical and pharmaceutical works, on which he anticipated building further.[427] He also evinced the desirability that there would issue forth from the Central Pharmacy Museum "through unified contributions of diverse specialists in

[426] Hermann Schelenz, "Nürnberg," *Mitteilungen zur Geschichte der Medizin und der Naturwissenschaften* 14 (1915): 296.
[427] Essenwein, "Das Mit Dem Germanischen Nationalmuseum Verbundene Historisch-Pharmazeutische Centralmuseum," 24.

the history of pharmacy, a precise descriptive catalogue…in which the history of each individual item would be considered." This, he noted, would need to be preceded by a thoroughgoing study of the historical sources; until that point, there had been very limited scholarly researches on the history of pharmaceutical apparatus or of individual substances used in medicine and pharmacy.[428] Peters had it in mind for the public to be edified about, not merely to experience agreeable diversion from, aspects of its past. It is interesting to note that the museum guidebook held that the pharmacist's laboratory "invited [visitors'] study".[429]

Within the Germanisches Nationalmuseum's pharmaceutical division, just as with the museum's scientific division, there was no rigid separation between "scientific" and "credulous" practices and operations, or between the business aspect of past pharmacy and the idiosyncratic ornamentation associated with its practice. The materials room would display, among other items, wonder-working objects such as amulets, magical letter combinations (abraxas), and magic rings that had in far distant times also formed part of the apothecary's healing armamentarium.[430] Medicaments of unfounded efficacy were brought together with such marks of prestige as fancy storage vessels, ornate and painted cabinetry, small sculptures and stuffed animals traditionally associated with pharmaceutical premises—giant tortoise shells, stuffed alligators, and other objects of natural history—and the apparatus and appurtenances of distillation, heating, and sublimation and efficacious drugs, pill dispensers, and medicinal herbs. Besides rooms associated with an apothecary's premises, Peters's plan included an alchemist's chamber with its apparatus for chemical manipulations. Many alchemical practices had direct continuities with subsequent chemical procedures, while the old publications associated with

[428]Ibid.: 25.
[429] Anonymous, *Die Kunst- Und Kulturgeschichtlichen Sammlungen: Wegweiser Für Die Besucher* (Nürnberg: Verlag des germanischen Museums, 1905), 172.
[430]Essenwein, "Das Mit Dem Germanischen Nationalmuseum Verbundene Historisch-Pharmazeutische Centralmuseum," 24.

truly efficacious pharmacy sometimes contained alchemical symbolism or magic incantations. It was consistent with the look backward at pharmacy's past to include alchemy. In fact, alchemist's dens were a popular favorite that made their appearance at the Germanisches Nationalmuseum, the Deutches Museum, and at the German exhibition at the St. Louis World's Fair, while the 1898 Düsseldorf exhibition included a set of alchemist's apparatus. Alchemy was a rich field of ambiguities and deliberate mysteries with strong German roots, and displays of its relics (which had a whiff of superstition) could, if needed, be justified by the element of chemical know-how they also represented.

The Pharmaceutical Central Museum found imitators abroad. In German-speaking sites outside of Germany, but elsewhere as well, pharmaceutical museums started to appear, as Peters noted in 1895.[431] The Germanisches Nationalmuseum had led the way.

MEDICO-HISTORICAL CABINET

The next scientific division to take shape at the GNM was the Medico-historical Cabinet. It signaled the further museum interest, for a time, in extending its representation of past science. As we will show, however, this unit, delayed in taking shape until well after the other two scientific units, was beset by various difficulties and did not fulfill all the hopes of its initial organizers. Still, it had some role in the museum's extension of the network joining people with an appreciation for the history of science.

At the museum's founding, there were only seven objects of specifically medical character mixed among several divisions. Not until 1893 did Max Emmerich make his first public appeal for the creation of a Medico-historical Cabinet at the museum. Emmerich came back to the issue in 1899, and after enlisting an energetic younger physician, Richard Landau, to

[431] Anonymous, "Historisch-Pharmazeutisches Zentralmuseum," Ibid.8, no. 3 (1895): 42.

move the effort forward, and after having garnered leading physicians' endorsements, the team of Emmerich and Landau went to the medical trade press to push their cause. They were successful in fund-raising in 1902 and again in 1903, and with the money donated they were able to start a collection of medical portraits, while another collection of medical medallions with exemplars extending back to the sixteenth century was purchased at auction in Amersterdam. When the cabinet opened to the public in 1904, it contained a wide variety of medical instruments, a few medical books including an anatomy text of Vesalius, documents going back to the fourteenth century, anatomical models, and medical caricatures.[432] Landau had been a key resource, commanding an expertise in medical history; neither museum director Bezold, nor his fellow staff members, were sufficiently expert to perform this task.[433] But Landau passed away in 1903, and left alone to the task, Emmerich failed to produce an inventory for the new cabinet.[434]

As with the Pharmaceutical Central Museum at the German National Museum, the new medical division did not attempt to sanitize its representation of earlier medical practice. The collection of cupping-instruments reminded the viewer that these devices had experienced periods of favor interspersed with other periods of neglect. Burning irons on display showed that this extreme means had long been used for certain medical conditions, including amputation and other required stoppage of blood flow.[435]

The display included a succession of the apparatus developed for gynecological purposes. Eyeglasses, a total of thirty-one exemplars, traced the history of their development

[432] Marion Maria Ruisinger and Thomas Schnalke, "Das „Medico-Historische Cabinet". Eine Vergessene Sammlung Im Germanischen Nationalmuseum Nürnberg," *Medizinhistorisches Journal* 35, no. 3/4 (2000): 363-69. Max Hirsch, "Das Medico-Historische Kabinett Im Germanischen Nationalmuseum Zu Nürnberg," *Gesundheit in Wort und Bild: moderne Zeitschrift für Familie und Haus* 2 (1905): 515.
[433] Ruisinger and Schnalke, "Das „Medico-Historische Cabinet". Eine Vergessene Sammlung Im Germanischen Nationalmuseum Nürnberg," 370.
[434] Ibid.
[435] Hirsch, "Das Medico-Historische Kabinett Im Germanischen Nationalmuseum Zu Nürnberg," 516-17.

from the fifteenth century. There were pumps for use in internal medicine, two of which were constructed by their inventor, the outstanding nineteenth century clinician Kussmaul.[436]

A number of exemplars in the Cabinet had distinct cultural-historical interest. The medallions were chiefly of interest for their age or were interesting through their representation of the key events of medical history. A male figure diagram for instruction in applying leeches was emblazoned with the identification of where best to position the leeches at specific times within individual months, with a zodiac as well indicating the close connection in the Middle Ages between medicine and astronomy. Four illustrations showed how the dentistry trade was once conducted itinerantly like other trades.[437] There was further a set of illustrations of the plague in different periods.

In 1905, Max Hirsch, a physician, gave an account of the Cabinet. He made first mention of a large, ornate armoire originally given to the Medical Clinic of the University of Landshut by the early nineteenth century King of Bavaria Maximilian Josef I. Housed in the armoire were primarily appurtenances for surgery, dentistry, and procedures during childbirth, extending back as far as the sixteenth century. Hirsch anticipated the creation of a full-fledged Museum of the Healing Arts through the extension of the Cabinet. Hirsch saw this anticipated development as the basis for the whole German nation to take pride in the site, beyond the doctors who were now implicated in its genesis. He finished up by highlighting the appropriateness of taking the new institution farther, for Germans were now "also first in medicine."[438]

But the efforts to build and improve the Medico-historical Cabinet, with the early death of Landau in 1903, lost their base of historical medical expertise. The upper-level official at the

[436] Ibid.: 519-21.
[437] Ibid.: 527-28.
[438] Ibid.: 532.

museum who worked most closely with Emmerich, 2nd Director Hans Bosch, in 1905 also died. Further, the donations tailed off before the First World War.[439] The Germanisches Nationalmuseum directorate itself did not conceal an ambivalence toward the project, assigning to the Cabinet a room in the museum that was remote from the other two science-related sections, the scientific division and the Pharmaceutical Central Museum.[440]

From the 1870s to the end of the German Empire, the Germanisches Nationalmuseum as a national site did important work to raise the awareness of the scientific historic German treasures and to stir the national pride in them. This was part of the museum's general mission to help forge a more coherent German national and cultural identity. Scientific achievement had become an integral part of the German national identity, and an emphasis at the museum on the early German science gave further substance to the idea of the Germans as a scientific race. Through contributions to the museum by a host of individuals, a widespread feeling arose among the Germans of their participation in its mission. The Nationalmuseum gradually, as it added science-related divisions, became a central site for science history during that period.

However, the promising start made there during the German Empire clearly appears to have dwindled before the start of the First World War, especially in the pharmaceutical and medical-historical divisions; the museum's own assessment in a 1913 annual report pointed to the political uncertainties in those pre-war years as ultimately responsible.[441] According to a chapter on the museum's scientific instruments in a 1978 publication, they too long languished

[439] Ruisinger and Schnalke, "Das „Medico-Historische Cabinet". Eine Vergessene Sammlung Im Germanischen Nationalmuseum Nürnberg," 371. Gustav von Bezold, "Hans Boesch," *Anzeiger des germanischen Museums* 18, no. 3 (1905): xxxiii-xxxv.
[440] Hermann Peters, "Die Medikohistorische Abteilung Des Germanischen Museums in Nürnberg," *Münchener medizinische Wochenschrift* 51, no. 38 (1904): 1701.
[441] Ruisinger and Schnalke, "Das „Medico-Historische Cabinet". Eine Vergessene Sammlung Im Germanischen Nationalmuseum Nürnberg," 374.

without any thoroughgoing scientific exploitation.[442] In 2000 an exploratory article on the Medical-historical Cabinet was subtitled "a forgotten collection in the German National Museum of Nuremberg"; in it, the observation was made that the great majority of the objects in it were already present at the turn (*Jahrhundertwende*) of the twentieth century.[443] Germany's instability from sometime prior to the start of World War I eroded the initiative to bring science more to the forefront at the German National Museum. Unlike the post-World War II Deutsches Museum, the National Museum's science-related units never rose again to become internationally important.

HAMBURG MUSEUM FOR THE ARTS AND TRADES

The Hamburg Museum for the Arts and Trades gives us another example of a collection which became a quite impressive site for the deposition of scientific relics. Since it was in a different part of Germany, it also suggests the geographically widespread nature of the network of the Germans with interests in the history of science that was forming.

As its 1894 catalogue relates, the Hamburg Museum was started through private civic initiative in 1877 as a venture to give Hamburg a rich collection to put it on a par with collections in the other major German cities. However, that catalogue indicates that some purchases were made with public funds.[444] It is probably best to conceive of it as a private-public venture.

Corresponding to the German National Museum, there was a cultural-historical orientation to the holdings at the Hamburg Museum. The director, from its founding through

[442] Willers, "Wissenschaftliche Instrumente."
[443] Ruisinger and Schnalke, "Das „Medico-Historische Cabinet". Eine Vergessene Sammlung Im Germanischen Nationalmuseum Nürnberg," 362.
[444] Justus Brinckmann, *Führer Durch Das Hamburgische Museum Für Kunst Und Gewerbe : Zugleich Ein Handbuch Der Geschichte Des Kunstgewerbes* 2vols., vol. 1 (Hamburg: Verlag des Museums, 1894), iv.

more than thirty-five years, was Justus Brinckmann, an eminent connoisseur of the arts. He insisted that the museum should enliven the sense for the joint work of the free arts with the trades. It would "instruct viewers...how in line with general culture and the particular morals and practices of a people, the striving to accommodate the demands of function and the need for the adornment of consumption are expressed." It was also the intent to expose the German people to the masterworks of the centuries which were more talented artistically than the present.[445] So far as the collection was presented in a way that showed cultural historical context, it would train the aesthetic sense of the common people.[446]

Evidently the museum had relatively few holdings of scientific apparatus in its early years. This presumption is founded on the 1894 museum catalogue, which mentions twenty-eight scientific objects, of which eleven of its larger objects were obtained at the time of the auction of the Spitzer collection in Paris. The Spitzer collection, one of the richest private collections of artistic objects ever, was auctioned in 1893, indicating that until that time, the museum boasted only seventeen scientific items. However, beyond the enumeration of twenty-eight scientific instruments in 1894, additionally the museum's furniture division had exemplars of pocket clocks, free-standing clocks and wall clocks.

In the 1894 museum catalogue, Brinckmann said that his purpose was to furnish a guide to the principal divisions of the technical arts. Brinckmann provided details on the pieces; along with the dimensions, the functional parts and the ornamental embellishments appeared. Since the museum was acknowledged to be cultural-historical, and the promotion of the welfare of people practicing the trades through cultivation of their artistic sense was one main if not the main overall goal of the Hamburg museum, a description of the embellishments was essential. The

[445] Ibid., iii-iv.
[446] Ibid., vi.

scientific instruments that had been acquired for Hamburg were chosen in part with regard to this goal. Thus, it is notable that whole realms of instruments, such as telescopes, microscopes, and early electrical machines, were not represented by 1894 in the museum's collection; these apparatus would in general not have been as richly decorated, and so as suited for training artistic sensibility, as the items which the museum did obtain.

Brinckmann gave some general information about the kinds of the navigational and artillery firing instruments that were in use in the Renaissance period. More than half of the twenty-eight objects were from the sixteenth century or earlier. Some of the Hamburg collection, as of 1894, were apparatus for determining geographical position.

The early origins of the Hamburg pieces were reminiscent of the age of the Germanisches Nationalmuseum collection. It is clear that their age and beauty made them desirable. No apparent effort was made, for the sake of more fully illustrating development of the instrumental methods, i.e. lines of development, to procure the instruments of times more recent than the early eighteenth century. This would in any case have been difficult given the limited number of pieces in the scientific collection.

Brinckmann took care to point out the two objects which served astrological purposes, underlining his interest in the items' cultural historical dimension. As with the organizers of the pharmaceutical and medical divisions of the Germanisches National Museum, Brinckmann did not cordon off elements of the past practice of natural knowledge that would, according to present understanding, have been considered superstitious.

The most impressive piece, and also the oldest, in the Hamburg collection was an Italian astrolabe from the end of the 15th century, said to be "one of the most beautiful made of its type," but not as exact as astrolabes made in Nuremberg in the late 15th century during

Regiomontanus's time there.[447] However, the bulk of the objects, more than three quarters, were of a German manufacture, including two-thirds of the objects bought from the Spitzer collection auction. An armillary sphere was one such, "of beautiful, decorated form". It embodied "artistry and scientific study, so they are in the right place in the Hamburg Museum."[448] The evidence suggests that the museum aimed to center its holdings on German-made items. In 1902, in a publication celebrating the twenty-fifth anniversary of the Hamburg Museum for Arts and Trades, meteorological and terrestrial magnetic observer Georg von Neumayer referred to a number of published works on nautical instruments "which show a German national perspective [and thus] can aid in understanding the very important collection" at Hamburg.[449] Five of the objects for which the German city of manufacture was known were made in Augsburg, one of the several prominent sites of the early German scientific apparatus manufacture. Of these, two were produced by the eminent sixteenth century instrument maker Christopher Schissler.

It's not likely that Justus Brinckmann and his fellow workers at the Hamburg museum anticipated providing exemplars of adornments to be drawn on in making contemporary *scientific apparatus*, which in the nineteenth century were rather designed along rational, utilitarian lines. The motifs and workmanship of older scientific items in the collection would instead have been helpful in ornamenting certain other products, particularly those of metal construction, which contemporary skilled German tradesmen might be called on to make.

Most of the 1894 Hamburg collection catalogue was made up of text. There were illustrations of two views of the Italian astrolabe and of a pair of German compasses; clearly,

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[447] *Führer Durch Das Hamburgische Museum Für Kunst Und Gewerbe: Zugleich Ein Handbuch Der Geschichte Des Kunstgewerbes* 2vols., vol. 2 (Hamburg: Verlag des Museums, 1894), 773. Georg von Neumayer, "Die Historisch Interessanten Astronomisch-Physikalischen Instrumente," in *Das Hamburgische Museum Für Kunst Und Gewerbe: Dargestellt Zur Feier Des 25-Jährigen Bestehens Von Freunden Und Schülern Justus Brinckmanns* (Hamburg: Verlagsanstalt und Druckerei A.-G., 1902), 246.
[448] Neumayer, "Die Historisch Interessanten Astronomisch-Physikalischen Instrumente," 249.
[449] Ibid., 238.

though, a visit to see the assembled items directly was needed to learn extensively from their decorative motifs.

The scientific holdings at the Hamburg Museum probably owed less to the general turn towards the history of science than at most of the other sites reviewed here. It was not only that the more recent instruments were not represented; this was true as well of the Germanisches National Museum's Science Division. More telling was the seeming indifference to the scientific purpose of its objects. Unlike the two older collections, at Hamburg the aesthetic quality was the *main* reason for the presence of the objects. However, others may have made use of the collection to illuminate historical details. Neumayer said, in his summary of the Hamburg collection, that using instruments of the past, one can resolve "certain disputes relating to observations and geographical determinations made with them."[450] But this was a guest writer's comment about historical instrument collections in general. Hamburg Director Brinckmann had shown in his 1894 catalogue that he was most attentive to the fine aesthetic qualities of his holdings.

By the 1890s, the collection of the Hamburg Museum for Art and Trades was sufficiently large to be counted among the important repositories of early scientific instruments in the Empire. The Spitzer auction had yielded the museum nearly half of its scientific collection. Perhaps the scientific nature of these pieces was partly incidental, in the sense that scientific instruments were among the exemplars of metalwork of earlier centuries on which were lavished, because even then they carried social cachet, the full fantasy and skill of the artisan. Each scientific item was an ornate treasure. Beyond decorative value, the instruments had the potential to be informative about the science of earlier times. However, the scientific collection, like the rest of the Hamburg collection, had as its priority instruction for tradesmen in metalwork and

[450] Ibid., 242.

other luxury worked items. Still, it brought before its viewers evidence that the Germans of earlier times had been both extraordinarily skilful in fashioning fancy metal productions, and that some of those skilled artisans had had significant scientific expertise. Both of these conclusions would have brought the German viewers a sense of an important tradition as part of their people's proud past, shoring up their commonalities among the members of the new nation and furthering the network of the German citizens appreciative of their nation's scientific past.

KAISERIN-FRIEDRICH HAUS

Another permanent site extending the network of the people gaining a sense for the history of science in Germany was the Kaiserin-Friedrich Haus in Berlin. Opening in 1906, it stood in honor of the public service of the widow of the Emperor Friedrich III (who died in the same year, 1888, that he inherited the throne) as an instructional facility for the further education of doctors. A foundation for this purpose had been founded in 1903 by Ernst von Bergmann. As part of Bergmann's plans for the site's inauguration, an exhibition was arranged. It was decided that the exhibition would have a focus on works in graphic arts, skilled crafts, and trades which exemplified topics of a medical or health character up until a century prior. The exhibition catalogue that appeared as the Kaiserin-Friedrich Haus first opened drew attention to a comparable emphasis at the temporary German Scientists and Physicians 1898 Düsseldorf meeting exhibition. The connection was more than notional, since Karl von Sudhoff had a hand in the Kaiserin-Friedrich Haus catalogue just as he had been the leading figure behind the Düsseldorf exhibition as well as of its catalog. But here in the Kaiserin-Friedrich Haus, the display would be permanent, and it would be housed in a public institution.

A medical journal commented that the objects in the exhibition were on a par with those of the 1898 Düsseldorf historical scientific exhibition "in richness and worth."[451] The chronological confluence of this exhibition with the 1899 Bavarian Court- and Realm-Library's medically oriented display and the 1904 founding of the Medico-historical Cabinet of the German National Museum are striking. The German historical orientation was plainly responsible in part for the origination of all of these, along with a pride within the field of medicine as a science in which the Germans were showing themselves to be leaders, and a pride in the new German nation. The aim of the Kaiserin-Friedrich Haus display was to put the "objects [in]… a context, [with]… an overview of development through time, and [to give]… the chance for them to serve as instructional objects and sources for study." The catalogue pointed out that individual items of medical pictorial content were preserved in the Germanisches Nationalmuseum, the Historical Museum at Basel, and the Berlin Marches Provincial Museum, but that these could offer only looking at isolated objects.[452]

It was significant that the exhibition catalogue alluded to an outflow of the historic artistic representations of medicine from Germany to other lands. The exhibition served as a clarion call that this endangered stockpile was valuable and that action should be taken to conserve such works and retain them in Germany.[453] The Kaiserin-Friedrich Haus was one of the German sites at which conservation was deemed a key component of exhibition.

The scope of the exhibition was remarkable, even though formally (though exceptions were made) restricted to those aspects of medicine shown in graphical works, i.e. portraits, illustrative medical/surgical works, and medallions. The assistance of the General Directorate of

[451] Walter Pagel, "Ausstellung Fur Geschichte Der Medizin in Kunst Und Kunsthandwerk Im Kaiserin Friedrich-Hause," *Deutsche Medizinische Wochenschrift* 32, no. 13 (1906): 511.
[452] Eugen Holländer, ed. *Katalog Zur Ausstellung Der Geschichte Der Medizin in Kunst Und Kunsthandwerk, Zur Eröffnung Des Kaiserin Friedrich-Hauses, 1. März 1906* (Stuttgart: Enke, 1906), 8.
[453] Ibid.

Royal Museums was instrumental in bringing the exhibition to life, and it ensured that the Berlin museums opened their archives for it. Two other institutions in particular made their portraits of physicians available to the organizers of the exhibition: the Kaiser-Wilhelm Akademie and the Senckenberg Institute of Frankfurt am Main. The former had been collecting historically rewarding objects in Berlin for two hundred years, but the objects were previously known "only to initiates".[454] There were loans from some forty institutions and forty-five individuals, including some in the Netherlands, France, Switzerland and the Hapsburg Empire.[455] In particular, key medical illustrative documents came from academic institutions in Amsterdam and Leiden.

The general subject of the exhibition was medicine and allied practices (alchemy, chemistry, pharmacy) insofar as these were reflected in the fine arts, in the artifacts of the trades, and in book and manuscript illustrations.[456] It differed from the Düsseldorf exhibition in that, while it included the old instruments, appliances, or utensils of medicine insofar as these were evidence of skill in production, it more emphasized the graphic representation of medical appliances, of practitioners and their patients, of old anatomical and medical illustrated texts, and of graphically adorned amulets.

There was explicit recognition at the Kaiserin-Friedrich Haus of the need to arrange objects instructively, through adjacency, showing their lines of development. This was thus another of the exhibitions in Germany during this period where this aspect received its due. It contrasted with the Düsseldorf event, which had been organized by scholars who seemed to struggle with arrangement and selection.

[454] Ibid., 9-10.
[455] Ibid., 16.
[456] Ibid., 7.

The head of the Kaiserin-Friedrich Haus exhibition decided that it would only target medicine of the times prior to the nineteenth century. The appeals then made to the directors of university medical collections turned up nothing. They responded to the call for loans that their collections *only* consisted of items of the nineteenth century.[457]

Eugen Höllander, who wrote the introduction to the catalogue of the exhibition, argued for the importance of an exposure to a diverse set of objects associated with physicians to aid in that aspect of medical student learning concerned with historical achievements, through the students' getting a "personal connection" with them.[458] As with the pharmacists, geographers, and mathematicians, the German physicians, in becoming acquainted with the history of their discipline, would know better how their profession had contributed over the centuries to the strength and advancement of human culture in general, and of the German people in particular.

Among the items of historic apparatus displayed at the Kaiserin-Friedrich Haus were field apothecary kits and splints for setting bones, throat forceps, bullet extractors and vaginal mirrors, a speculum for the rectum, tweezers, dental forceps, amputation and trepanation set, delivery instruments, and spectacles. There were also pharmacists' vases. From the Roman medical world, tweezers and dental forceps, probes, lances, raspatoria (surgical shavers), needles, scissors, a knife, a saw, a plaster spatula, a wound fastener and a speculum were other attractions, including a set of reproductions from the medical historical institute at Leipzig headed by Karl von Sudhoff and originals from the collection of Eugen Höllander. From the late Stone Age, saws, borers, knives, shavers and scrapers from flint made an appearance.[459] But together with all these scientific finds was a Roman votive bronze intended to invoke cure from

[457] Ibid., 8-9.
[458] Ibid., 8.
[459] Ibid., 73-83.

the gods. So, finally, an exhibition of historical artifacts went all the way back to mankind's earliest attempts to treat patients.

As was to be expected, the illustrations of books were one rich source for the exhibition. Treatment of plague, distillation, surgery, anatomy, and bone breakage were among the illustration topics. The monasterial illustrated works on medicine from the thirteenth to the seventeenth centuries were jewels of the exhibition.[460] There were portraits of physicians reaching back to the fifteenth century.[461] The materials extended to a variety of satires on physicians, charlatans, barber-surgeons, and dentists. A prolific collection of coins and commemorative medallions relating to medicine included those with the themes of the plague and immunization.[462] These were joined by nineteenth century cholera amulets.

The Kaiserin-Friederich Haus functioned primarily to serve physicians. Its medical exhibition enhanced the professional self-awareness and self-esteem of the professional medical practitioners through the use of historical artifacts, and was an expression of the interest German physicians were taking in the past of their profession. It was a permanent exhibition that, through its positioning in a center for classes for ongoing advanced instruction for physicians, would remind them of the deep roots of their profession at the same time they were improving their personal competencies and professional standing. As leading members of the bourgeoisie, nineteenth century German physicians had significant social status. They underlined their profession's contribution to the new nation by providing materials that colorfully represented the significant role it had long played in German society. The visitor to the exhibition would have enjoyed its diversions, while increasing his conviction that the nation's supports included that of the medical profession, a cadre in whose membership he could be proud. The Kaiserin-Friedrich

[460] Ibid., 166-67.
[461] Ibid., 43-51.
[462] Ibid., 92-110.

Haus, along with the 1899 Bavarian Court- and Realm-Library's medically oriented display and the the Medico-historical Cabinet of the German National Museum, by forwarding medicine among those aspects of science whose past was being retrieved, extended the network of the Germans gaining an appreciation for the history of science.

DEUTSCHES MUSEUM OF THE MASTERWORKS OF THE NATURAL SCIENCES AND TECHNOLOGY

We turn next to the making of a German national science museum whose genesis took place in 1903, with a 1906 opening. Beginning in the years immediately after its opening, there was an impressive national public outpouring of support for it. Since then, it remains a home to the German pride in science. The early narrative of this national museum, together with the many smaller-scale representations of the history of science in the other scientific displays organized by the Germans, convey something of the depth and breadth of their attraction to the history of science during the late Imperial era. Because of the massive size of this site, but moreso because of the many elements in German society that directly contributed to its erection and its collections, and the rhetoric that linked the museum to a common national cause, it here receives a longer detailing than that afforded to most of the other sites considered. The creation of the Deutsches Museum was a culmination of the Germans' interest in the history of science. Even had the Germans organized little else during the Empire in the way of historical scientific exhibitions, the initiation of the Deutsches Museum would have contributed a great deal towards the formation of a network of those Germans who shared a notion of the relevance of science's past to supporting a vibrant national self-image.

The strong historical emphasis at the Deutsches Museum—balanced by some exhibits of contemporary science—was forcefully accented in the professional organ of the Society for German Mechanical and Optical Engineering as it got underway in 1904, reflecting this bent even in the museum's initial planning stage. The very first paragraph devoted to the nascent museum in this publication opened with the institution's initiation of a new emphasis on technology's past.

> German technology has [only] in recent decades seized a significance and rank that places it alongside the other sciences, and as a result it was previously not in a position to lay hold of the past and to collect…Only in the most recent times have people taken up the task, conceived from a higher standpoint, to make possible…a view of the past [of technology].

The article also made clear that the upcoming museum, in having an archive of designs and a library, would have as its focus exemplars of historical significance.[463] A month later, a follow-up article in the same publication referred to an audience of the museum's leadership with Kaiser Wilhelm II, where it presented its *bona fides*, at which the Kaiser expressed his concurrence with its aim to worthily display "the precious historical masterworks of science and technology."[464]

Oskar von Miller, an engineer with a vision for a celebration of science that would instruct and entertain, was responsible for the founding of this unique German institution. Miller from the outset wished that the Deutsches Museum show a pronouncedly national character. He put it this way in his initial call for interest in founding the museum: it should be a "German national institution, designated to serve to the honor of and as a model for the whole German people [*Volk*]." In the early proceedings of the museum, an official who supported its mission, Count Posadowsky, referred to the importance of its maintaining "the character of an institution

[463] Anonymous, "Museum Von Meisterwerken Der Naturwissenschaft Und Technik," *Deutsche Mechaniker-Zeitung* 3 (1904): 21.
[464] "Museum Von Meisterwerken Der Naturwissenschaft Und Technik," *Deutsche Mechaniker-Zeitung* 5 (1904): 45.

meant for the whole German people unified in the Empire."[465] These sentiments were soon seconded by Kaiser Wilhelm II, wishing that the museum function as a national institution similar to the Science Museum in London and the *Conservatoire* in Paris.[466]

Probably to garner some of the cultural cachet of art museums for science, as well as to honor German science's most worthy representatives, the Deutsches Museum from the beginning had a Hall of Honor where the portraits and busts of the most renowned German scientists and engineers would preserve the memory of their excellence and impact. In the first iteration, in 1907, Leibniz, Guericke, Fraunhofer, and Gauss were the scientific representatives in the Hall of Honor. Others who were next in line were Helmholtz, Mayer, Liebig, the armorer Alfred Krupp, Johannes Gutenberg, Werner von Siemens, and Bunsen. Within a few more years these Hall of Honor memorials had been augmented by ones of Kepler, Reichenbach and the locomotive constructor August Borsig.[467] Among the artifacts on display in the Hall of Honor were correspondence of Ampère, Berzelius, Faraday, and Ohm.[468]

The Hall of Honor was an opportunity for patronage on the behalf of individual German scientists and engineers, and the dedications of the objects within it could resemble the commissions of the memorial statues or portraits to scientists in their native towns or towns hosting universities where they were active. The King of Württemberg commissioned a portrait of Kepler for the Hall of Honor. German associations like that of the national Foundry Association and the Publishers Association made gifts of a portrait of the father of German mechanical engineering Reichenbach and a bust of Gutenberg, respectively, for it.[469]

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[465] Albert Stange, *Das Deutsche Museum Von Meisterwerken Der Naturwissenschaft Und Technik in München: Historische Skizze* (Munich: Oldenbourg, 1906), 45.
[466] Anonymous, "Museum Von Meisterwerken Der Naturwissenschaft Und Technik," 45.
[467] *Deutsches Museum München: A Walk through the Collections* (Munich: R. Oldenbourg, 1917), 34.
[468] Bennett H. Brough, "The German Museum of Science and Technology," *Nature* 78 (1908): 478.
[469] Anonymous, "Bericht Über Die Sechste Ausschusssitzung," 31-32.

In 1904 Miller revealed an intention that the museum be "useable not only for scientists [*Gelehrte*] and engineers but for the edification of wider circles of the [German] people."[470] One commentator affirmed this a year later.

> The museum has developed to an institution of the people in the widest sense. Representatives of science and technology use this one-of-a-kind cultural medium alongside the simple man from the people. Notable elders are astounded by the triumph of human intellect and whole troops of curious youth wander daily in the halls of the exhibition in order to study the laws of nature and their validity to test on models made for this use.[471]

Famed physicist Wilhelm von Röntgen spoke at the founding of the Deutsches Museum of its broad national, patriotic aim.

> It is...the expressed intention and complete wish that the activity of the society [constituting the Deutsches Museum] extend itself to the whole German land. In the ideal which the enterprise has in view, we are one with a prince who unstintingly takes an interest to work for the welfare and the prospering as well as for the stature of the German people, with His Majesty the German Kaiser.[472]

Like in the old German cities, in which the populace pooled its efforts to build cathedrals and town halls, the Germans of restricted means looked on the museum as a special recipient of their gifts; by contributing in a small way, they believed, they were helping to show the German national substance.[473] Workers contributed their time, industrialists gave necessary building supplies, and artists worked free of charge or for very small compensation.[474]

Not only was the museum a focal point for drawing forth national feeling, but it served to impress on the nation's people the distinct role of science and technology in the advancement of German prestige and power. In 1908, Felix Klein, a mathematical *éminence grise* and advisor to

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[470] "Museum Von Meisterwerken Der Naturforscher Und Ärzte," *Zeitschrift des Vereines Deutscher Ingenieure* 48, no. 2 (1904): 1113.
[471] Link, *Das Deutsche Museum Im Dienste Des Physikalischen Unterrichts*, 3-4.
[472] Stange, *Das Deutsche Museum Von Meisterwerken Der Naturwissenschaft Und Technik in München: Historische Skizze*, 15.
[473] Zdenka Hlava, "Kleine Zeitgeschichte, Gesehen Von Der Museumsinsel in Der Isar," *Kultur & Technik.* 8, no. 1/2 (1984).
[474] Oskar von Miller, *Technische Museen Als Stätten Der Volksbelehrung* (Berlin: Deutsches Museum, 1929), 16. Anonymous, "Verwaltungsbericht Über Das Sechste Geschäftjahr," (Munich: Deutsches Museum, 1909), 16-17.

the Deutsches Museum, saw the *Deutsche Museum*'s mission as being of the broadest import to German society: it was "exceedingly important, that the significance of science and technology is in a new way brought to the general awareness" by the museum.[475] In 1905 Sudhoff expressed a patriotic enthusiasm for the Deutsches Museum that showed how science and its history had become redolent of the national stature, while the enterprise itself served to rally together various sectors of the population: it would be accomplished "with the help of an enlightened city administration, an understanding representation of the people, the magnanimity of the never ending direction of the Empire and its representative bodies, and not last the mighty, never sleeping German industry."[476] The German Emperor took a personal interest in it, cabling: "I anticipate from the new museum an essential support of the German natural sciences and technology, which already now assume a so highly-regarded position in the world."[477]

The museum, even in anticipation, also functioned as evidence on the *world-stage* of the German superiority. An article in 1905, before the museum had opened, enjoined: "[m]ay the circle of people who have determined to stake their work and interest on behalf of this national project, continually grow, then it will succeed…to make this a monument of scientific-engineering research, as it has never been found the world over."[478] The next year, as the proof that the museum, once opened, was viewed as a monument to an impressive German vision and an ability to bring projects to fruition, Karl von Sudhoff exclaimed that it "embodies in great scale the forceful, everything-urging-on power of German creation.[479] Conrad Matschoss, later a

[475] Anonymous, "Bericht Über Die Sechste Ausschusssitzung," 35.
[476]Sudhoff, "Zur Grundsteinlegung Des Deutschen Museums Von Meisterwerken Der Naturwissenschaft Und Technik Am 13. Nov. 1906," 2251.
[477] Stange, *Das Deutsche Museum Von Meisterwerken Der Naturwissenschaft Und Technik in München: Historische Skizze*, 16.
[478] Gary, "Deutsches Museum Von Meisterwerken Der Naturwissenschaft Und Technik " *Dinglers Polytechnisches Journal* 324, no. 14 (1905): 220.
[479] Sudhoff, "Zur Grundsteinlegung Des Deutschen Museums Von Meisterwerken Der Naturwissenschaft Und Technik Am 13. Nov. 1906," 2250.

powerful advisor to the museum, wrote in 1907 that "a marvelous organizing [of the great patriotic enterprise] produced from the colorful welter [of the creations of old and new engineering] a noble, richly structured and lucid portrait of the course of development of engineering and of natural science."[480]

The government at various levels clearly saw a potential for the museum to contribute to the local, regional and national solidarity, sense of purpose, and historical legitimacy. As an example, one Bavarian ministry in the pre-opening phase sent a representative to the Bavarian universities, lycées, gymnasia, and industrial schools to locate any historical apparatus that could be delivered to the Deutsches Museum.[481]

Deutsches Museum co-director Walther von Dyck was emphatic that while the museum, covering the scientific advances over the centuries, would of necessity be international in scope, yet its collection's original apparatus would show an emphasis on German-made items. "All nations have worked at the common structure [*Bau*] [of science] in the same way, if also in characteristic individuality with their leading workers [*Kräfte*]." The visitors would experience the personality of the scientists in such original work, and there "the museum should be above all else a German, a national [museum]." For the Deutsches Museum's distinctive national signature, "it should be the pride of our German institution, to represent in German work how…the natural connecting of theoretical and practical methods of research has abetted both technology and science."[482]

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[480] Conrad Matschoss, "Ein Besuch Im Deutschen Museum in München," *Zeitschrift des Vereines Deutscher Ingenieure* 51, no. 25 (1907): 976.
[481] Franz Fuchs, "Zum 100. Geburtstag Von Oskar V. Miller " *Physikalische Blätter* 11, no. 5 (1955): 218.
[482] Dyck, *Über Die Errichtung Eines Museums Von Meisterwerken Der Naturwissenschaft Und Technik in München*, 23.

In 1906 Sudhoff beamed that the Deutsches Museum "is born from this young historical [scientific] spirit" which had recently taken hold in Germany.[483] His view of the impending spirit rested on the 1898 Düsseldorf exhibition, on the increased attention of scholars to the history of science including the constitution of the German Society for the History of Science and Medicine, and maybe as well on other historical scientific displays.

People close to the Deutsches Museum insisted that it was not meant to be "a storehouse of more or less interesting objects, nor a collection for a few historical researchers," nor a "conglomerate of rarities."[484] In 1906 the state official Posadowsky, speaking at the inauguration of the museum, wished that it would, "in a period deeply imprinted by natural scientific knowledge and technological achievements, extend the understanding of these areas through an exposition and conduct through its historical stages."[485] One observer in 1911 commented that the *Deutsche Museum*'s collection was not a dead heap of treasures but a living, growing organism, sustained by nutriments and assimilation (meaning individual acquisitions and take-over of whole collections).[486]

There seems to have been an atmosphere around the turn of the century in Germany in which the idea of Germans' collecting and preserving their technological patrimony was circulating. There was a striking relationship between the talk given at the 1901 Scientists and Physicians meeting by Julius Ephraim mentioned above titled, "The meaning and prosecution of historical research for the technical sciences", with its call for the preservation of factory documents and for factory owners' biographies drawing on interviews with them, and the ideas

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[483] Sudhoff, "Zur Grundsteinlegung Des Deutschen Museums Von Meisterwerken Der Naturwissenschaft Und Technik Am 13. Nov. 1906," 2251.
[484] Conrad Matschoss, "Einleitung," in *Das Deutsche Museum, Geschichte, Aufgaben, Ziele*, ed. Conrad Matschoss (Berlin: VDI-Verlag gmbh, 1925), 3. Fuchs, "Der Aufbau Der Astronomie Im Deutschen Museum 1905-1925," 8.
[485] Stange, *Das Deutsche Museum Von Meisterwerken Der Naturwissenschaft Und Technik in München: Historische Skizze*, 45.
[486] Link, *Das Deutsche Museum Im Dienste Des Physikalischen Unterrichts*, 43.

that gave rise to the Deutsches Museum.[487] Ephraim's call for preservation was mirrored by the Deutsches Museum co-director Walther von Dyck's call in 1903 for preliminary diagrams, sketches and calculations that had been used in scientific research.[488] Twenty-five years later, Dyck noted that "[p]eople at the founding of the Deutsches Museum recognized that there was still time to save objects from destruction and forgetting and that now was precisely the right time to enlist participation and interest in the wide circles of the population…"[489]

The currency in Germany of the idea of the preservation of scientific treasures is also found in the private correspondence of 1903 between the German engineer Eugen Hartmann, the president of the Frankfurt Physical Society, and Miller during the founding stages of the Deutsches Museum. Hartmann, writing in response to Miller's asking him to be a part of a committee for the genesis of the museum, agreed to the request while disclosing that he had himself had been spreading the idea of a similar venture in Frankfurt to be accomplished within the new buildings of the Physical Society. But, he pointed out, "[t]here is no doubt that Munich, the city where a Fraunhofer, a Reichenbach lived and worked, is a more suitable location for such a museum than Frankfurt." [490]

In important respects, the Deutsches Museum worked along the lines of two existing establishments, the *Conservatoire des arts et métiers* in Paris and the Science Museum in London.[491] Miller affirmed that it was his visit to the *Conservatoire* in 1881 that had first stirred

[487] Jules Ephraim, "Die Bedeutung Und Ausführung Geschichtlicher Forschung" (paper presented at the Verhandlungen der Gesellschaft Deutscher Naturforscher und Ärzte, 1902), 79.
[488] Dyck, *Über Die Errichtung Eines Museums Von Meisterwerken Der Naturwissenschaft Und Technik in München*, 22.
[489] Walther Dyck, "Wege Und Ziele Des Deutschen Museums," *Abhandlungen und Berichte -- Deutsches Museum* 1, no. 1 (1929): 3.
[490] Hartmann.
[491] This is explicit in the text of Dyck, *Über Die Errichtung Eines Museums Von Meisterwerken Der Naturwissenschaft Und Technik in München*, 2.

in him the thought that something comparable could be erected in Germany.[492] But what distinguished the *Conservatoire* throughout the nineteenth century were the three areas of experimentation, education, and representation—not so much preservation, a hallmark of the Deutsches Museum.[493]

Miller, having made more recent study trips to visit the two great existing museums of science and technology in Britain and France, as he proceeded with opening the Deutsches Museum was alerted by Hartmann to the relevance of consulting the German and maybe British publications resulting from the 1876 London exhibition. Miller would also have been reminded of the significance of the 1876 London exhibition for the Deutsches Museum in a speech which museum co-director Walther von Dyck delivered in 1903. Dyck recalled the 1876 exhibition as being, along with the 1851 World's Fair, the two building blocks on which the South Kensington Museum's scientific collection was assembled. The published version of the speech, appearing in 1905, also detailed in its notes the several books issued in conjunction with the 1876 exhibition, Dyck had very likely consulted all these works; as described above, he had deeply familiarized himself with the 1876 Catalogue before the 1893 Nuremberg *mathematical* exhibition. Miller may have been familiar with the content of both of these works through his museum co-Director Dyck.

Its directors intended that the Deutsches Museum should serve a broad range of visitors through its manifold well-organized series of development. This was becoming a tradition at various temporary and permanent German historical scientific displays, reaching back indeed to the Special Loan Collection of 1876 that had launched subsequent German temporary display of scientific relics. Dyck was duly impressed in 1903 by the fact that in 1876 the London

[492] Anonymous, "Bericht Über Die Sechste Ausschusssitzung," 28.
[493] Bruno Jacomy, "Du Cabinet Au Conservatoire: Les Instruments Scientifiques Du Conservatoire Des Arts Et Metiers Á Paris," *Journal of the History of Collections* 7, no. 2 (1995): 228.

"exhibition was completely arranged according to the historical and scientific standpoints" and produced dividends "especially for the natural sciences through the comparative observations" made possible there.[494] According to the conservator Franz Fuchs who worked at the Deutsches Museum alongside Miller from 1905 and retired from it only in 1952, the Deutsches Museum had made this organizational principle its own by 1909.[495] Miller orchestrated the displays "to show the coming into being of the natural sciences and technology, through historically-ordered series of development of apparatus and machines."[496] In Miller's own words,

> [a]side from the originals and replicas of German and foreign principal masterworks, which equally illustrate the foundation or the start of entire lines of development, and which should be especially emphasized in the museum, the individual intermediate members of these lines must however also have representation in the museum, for the development of natural science and technology, which only gradually proceeds from one key advance to another, and not in jumps, to be essentially embodied.[497]

The presentation of series would allow the visitors to gain some insight into the development of the devices for particular scientific or technological needs. To ensure an effective presentation of the series of development, "the inferior, which could obscure the picture", must be excluded.[498] In its aircraft section, Miller asserted, "self-evidently we will acquire only models which are truly a link in the development of flying machines, not every experimental apparatus, such as today are many times made by people not truly called to the task [*Unberufenen*]" of charting their technological development.[499]

Miller was concerned to illustrate the development of apparatus over time. For example, he looked to show the step-wise advances in the scientific investigations of the properties of

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[494] Dyck, *Über Die Errichtung Eines Museums Von Meisterwerken Der Naturwissenschaft Und Technik in München*, 7.
[495] Anonymous, "Bericht Über Die Sechste Ausschusssitzung," 37.
[496] Franz Fuchs, "Zur Entwicklungsgeschichte Der Physikalischen Abteilung Im Deutschen Museum," *Physikalische Blätter* 7, no. 12 (1951): 543.
[497] Quoted in Stange, *Das Deutsche Museum Von Meisterwerken Der Naturwissenschaft Und Technik in München: Historische Skizze*, 29.
[498] Anonymous, "Bericht Über Die Sechste Ausschusssitzung," 37.
[499] Ibid.: 27.

heavenly bodies.[500] From the outset, his astronomical apparatus wish-list reflected a desire to assemble series. Fuchs found in 1911 that already the optics and the lighting sections were nearly complete in their historical progressions. Miller would, if there was no chance of acquiring a pivotal piece of equipment, have a replica made of it.[501]

But where the original items could not be acquired, in addition to the replicas sometimes reduced-scale models were created, and schematic diagrams also helped to fill in any gaps and reveal the inner construction of pieces.[502] The museum had a workshop where it could build replicas or models, and sometimes it commissioned outside firms to do such work. One example was the replica of the British locomotive "Puffing Billy", paid for by the Association of German Railway Directorates, executed by the Royal Central Workshop in Munich.[503] At times the museum commissioned replicas from the illustrations in old manuscripts.[504]

Along the lines of the open-air museums in Scandinavia that Miller had visited and admired, the Deutsches Museum undertook that parts of selected old industrial facilities in Germany in which technology had played a role were taken down and located within the museum. Thus was an old Black Woods clock workshop recreated, an old brewing operation, a mine.

As Miller provocatively wrote, he wanted the museum to draw visitors like the stalls of the annual fair, and in another place called technical museums places of the people's instruction or guidance (*Volksbelehrung*).[505] In this he succeeded, for as Leo Wehrli reported in a newspaper article in 1912 (and reprinted by the museum in 1913), "study organizations, schools, teacher

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[500] Fuchs, "Der Aufbau Der Astronomie Im Deutschen Museum 1905-1925," 33.
[501] Ibid.: 27.
[502] Dyck, *Über Die Errichtung Eines Museums Von Meisterwerken Der Naturwissenschaft Und Technik in München*, 24.
[503] Anonymous, *Führer Durch Die Sammlungen (Deutsches Museum)* (Leipzig: B.G. Teubner, 1907), 37.
[504] Fuchs, "Der Aufbau Der Astronomie Im Deutschen Museum 1905-1925," 27.
[505] Miller, *Technische Museen Als Stätten Der Volksbelehrung*.

associations, craftsmen associations, worker associations, scientific, technical and industrial bodies" were all making the pilgrimage to the museum a mere six years after its opening. A Russian corps of five to six hundred teachers was also making the trip annually.[506] In his article, titled "*Eine Unterrichtsreise nach München"* (*An educational trip to Munich*), Wehrli underscored the "immeasurable element of *Bildung*" offered to the school visitors of the museum.[507]

From its opening the museum had an archive, a library, and a collection of technical designs extending back two centuries. The museum library was set up to house "the most important original texts of natural sciences and technology of old time…for the purposes of historical studies."[508] The archive had many materials which could not, due to space and intended emphasis, be presented in active display areas. But the archive was conceived to be a critical part of the museum's provision of the resources and relics of the past, and to serve scholarship widely. It contained "documents, manuscripts of historical interest, and photographs."[509] The archive also incorporated graphics, such as prints extending back to 1727, including prints of the oldest steam engines installed in Germany.[510]

By the time the first comprehensive guide to the Deutsches Museum was produced, two years after its opening, the library already had twenty thousand works. The design collection was said to be a "new and especially valuable source of instruction" and while it would have been in the first instance intended for use of engineers for their contemporary work, the collection would

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[506] Leo Wehrli, "Eine Unterrichtsreise Nach München," *Vorträge und Berichte -- Deutsches Museum* 12 (1913): 2, 16.
[507] Ibid.: 19.
[508] Fuchs, "Der Aufbau Der Astronomie Im Deutschen Museum 1905-1925," 18.
[509] Anonymous, *Führer Durch Die Sammlungen (Deutsches Museum)*, 5.
[510] G. Dietrich, "Das Museum Von Meisterwerken Der Naturwissenschaften Und Technik in München " in *Verhandlungen Der Gesellschaft Deutscher Naturforscher Und Ärzte*, ed. Albert Wangerin (Leipzig: F.C.W. Vogel, 1905), 51.

also have been a potentially rich source for scholarship.[511] The museum had an active publication activity beyond its guidebook, producing its *Vorträge und Berichte* (*Lectures and Reports*) series from 1906-1917 and, after resumption post-war from 1926, under the altered name *Abhandlungen und Berichte* (*Essays and Reports*). History of science and technology was well represented among the contents of this house organ.

Miller and his co-director Walther von Dyck shared a good deal of a vision of the wide-embracing educative function for the museum. In 1903 already, Dyck orally laid out the lines along which he saw the arrangement of objects in the museum being shaped:

> The totality of the objects comprehends a variously segmented but also multiply joined together arena. The spatial arrangement [in an exhibition] requires a cutting apart of many of the existing connections. The mutual relationships, in which they stand, must be carried into [the visitor's] visual perception [*Anschauung*] with special care. However, not only actual interrelationship of the objects must be fully brought out, but above all, their relationships to the era (*Zeit*) and the circumstances of their origination.
> An account-taking of the level of what was known, of scientific conceptions and not least of the level of the technology of the time in which a production was made, first allows us to make a proper judgment of it. The greatness of the discovery, the difficulty of the construction of the steam engine will first be fully realized, when one thinks that at [Denis] Papin's [the developer of a model and a partial prototype of a steam engine] time neither exact conceptions of steam pressure nor thorough measurements were available, and apparatus for measurement of heat did not exist at all.[512]

The accommodations and conditions at the museum were meant to be inviting. Miller was continually interested in expanding the circle of those who would visit the Deutsches Museum. The long hours of opening, organized tours, accessible non-expert lectures, and constant readiness of the staff to assist were distinguishing features.[513] Historically renowned experiments were recreated through drawings and models, and one commentator found this to be more profitable for school visitors learning about the principle of a physical effect than a

[511] Anonymous, *Führer Durch Die Sammlungen (Deutsches Museum)*, 151.
[512] Dyck, *Über Die Errichtung Eines Museums Von Meisterwerken Der Naturwissenschaft Und Technik in München*, 24.
[513] Matschoss, "Einleitung," 3-4.

rehearsal of contemporary cutting-edge experiments would have been.[514] The museum was very active in bringing in student groups and workers associations through lowered prices.[515] For example, students in groups with teachers had to pay a low enough entrance fee that even those without resources could probably make one or several visits.[516] In 1913 Miller asked for the funds from a benefactor to enable travel grants to the museum to be made, in order to select particularly worthy students to come spend a study week there.[517] Through all these means, many teachers, students and workers made their way to the museum.[518]

Clear explanatory text aiding the visitors in their understanding of the museum objects was a priority at the museum. In 1929 Miller said that "[d]rawing up readily understandable but satisfactorily brief textual explanations is one of the most difficult but effective tasks of a scientific-technical museum."[519] Further, he claimed that for a museum whose mission is the public edification, "attention to thorough explanation is the chief assignment."[520] The emphasis on good explanations can already be seen in the first catalogue of 1907. In 1908, Miller was able to proclaim that in that very year, written explanations had been created to accompany the collection items through the efforts of consultants and co-workers.[521] That such efforts were successful was already apparent in 1913 when Leo Wehrli gave his account of his trip through the museum with its "short, excellently composed explanations."[522] Going back to a theme in section 0.1.3., abstracted from Sam Alberti's work on the "career" of museum display items, the

[514] Link, *Das Deutsche Museum Im Dienste Des Physikalischen Unterrichts*, 5.
[515] Carl von Linde, "Geschichte Des Deutschen Museums," in *Das Deutsche Museum, Geschichte, Aufgaben, Ziele*, ed. Conrad Matschoss (Berlin: VDI-Verlag, 1925), 13; Link, *Das Deutsche Museum Im Dienste Des Physikalischen Unterrichts*, 4.
[516] Link, *Das Deutsche Museum Im Dienste Des Physikalischen Unterrichts*, 9.
[517] Linde, "Geschichte Des Deutschen Museums," 15.
[518] Miller, *Technische Museen Als Stätten Der Volksbelehrung*, 13.
[519] Ibid., 7.
[520] Ibid., 9.
[521] Link, *Das Deutsche Museum Im Dienste Des Physikalischen Unterrichts*, 4.
[522] Wehrli, "Eine Unterrichtsreise Nach München," 3.

objects in the Deutsches Museum enjoyed unusually favorable conditions for their flourishing in that they were ranged alongside many other masterworks, all with concise and careful explanations, and as Dyck stated above, the museum's administration made every attempt that "the mutual relationships, in which they stand,…[be] carried into [the visitor's] visual perception [*Anschauung*] with special care," yielding visitors a high-value encounter with them.[523]

A provisional housing served the collections more than well until 1925, for there was an average of 300,000 visitors per year, reaching that figure in 1910 and increasing yearly until the outbreak of war.[524] For the war year 1915/1916, by contrast, the total number of visitors was down to approximately 142,000.[525]

The donated historical objects would acquire increased meaning by being shown alongside a more complete set of related instruments than their original possessors might have possessed and, particularly at the Deutsches Museum, they would enjoy the opportunity for better conservation and documentation using its curatorial or scholarly resources. These conditions at the museum elicited a remarkable response. For the year 1908-9, for example, two thousand objects entered the museum's collection, the large majority of them as gifts.[526] One donation came from Professor Lehmann of the Karlsruhe Technical College. He provided Heinrich Hertz's apparatus which had enabled the detection of electromagnetic waves. The item was the most precious one in the collection overseen by Lehmann. By turning over this relic to the Deutsches Museum, he "believ[ed] it would to the greatest degree serve to awaken in the widest circle of the German people the understanding of how through noiseless, hardly

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[523] Dyck, *Über Die Errichtung Eines Museums Von Meisterwerken Der Naturwissenschaft Und Technik in München*, 24.
[524] Conrad Matschoss, "Einleitung," in *Das Deutsche Museum, Geschichte, Aufgaben, Ziele; Im Auftrage Des Vereines Deutscher Ingenieure Unter Mitwirkung Hervorragender Vertreter Der Technik Und Naturwissenschaften*, ed. Conrad Matschoss (Berlin: VDI-Verlag gmbh, 1925), 4-5; Richards, *The Industrial Museum*, 30.
[525] Anonymous, "Tagesrundschau," *Zeitschrift für angewandte Chemie* 30 (1917): 547.
[526] "Bericht Über Die Sechste Ausschusssitzung," 26.

perceptible activity in scientific laboratories a foundation is laid for the further development of technology and thereby for the progress of our whole culture."[527] Thus additionally did the Frankfurt Physical Society, Berlin University, and many other donors, from an early stage in the Deutsches Museum's existence, concede to it the central position in orchestrating a view of the history of German science for the nation.

There was an element of excitement in the work of the museum, where securing the material remains of history of science and technology was an immediate and passionate enterprise. But it was also methodical. "We've gotten evaluations of the apparatus we're seeking through letters, trips and viewings…", Miller wrote.[528] He pursued authenticity where possible, even as he permitted replicas of important instruments to substitute for the originals. For example, the museum acquired an important Fraunhofer instrument which currently had a replacement lens. Miller ascertained where the original lens was and bargained (unsuccessfully in this instance) to exchange another lens of greater power to obtain it.[529] Fuchs consulted a scholarly manuscript to determine the configuration of the supports for a 1250 Arabic quadrant.[530]

Dyck, if not Miller, also placed stress on the material gorgeousness of some apparatus. He viewed attention to artistry in instruments as characteristic of the early period of design and construction: "In the museum for full understanding of the achievements of an era there must also be an expression of the direction and taste of that time."[531] Germans could be proud of their culture's tradition of beautiful metalwork.

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[527] Dyck, "Wege Und Ziele Des Deutschen Museums."
[528] Miller, *Technische Museen Als Stätten Der Volksbelehrung*, 3.
[529] Fuchs, "Der Aufbau Der Astronomie Im Deutschen Museum 1905-1925," 42.
[530] Ibid.: 50.
[531] Dyck, *Über Die Errichtung Eines Museums Von Meisterwerken Der Naturwissenschaft Und Technik in München*, 25.

The Deutsches Museum was particular as to how it housed its scientific relics as well. Throughout, what was stressed was the dignity of science and technology, and this could be brought out by finely tooled bases or cabinets, reminiscent of the 1876 Special Loan Collection, and recalling in its visitors their encounters with works in ornate frames at art museums, consistent with the understanding of science and technology as cultural goods. Prior to their acquisition, the Deutsches Museum tried to gain sketches or photographs of prized objects so that a fitting set-out could be devised.[532]

The museum assayed in a number of ways to do what would today be called outreach, to enable the untutored to gain access to a realistic sense of science. In 1907, already fifteen thousand guides to the museum had been printed.[533] Beginning in 1908, the museum offered guided tours of the various departments, led by the advisors serving the museum. To ensure quality of these tours was a key desideratum. Miller personally listened to all tours in advance of their being offered to the public, and made changes to them.[534] In 1910 a provision was made for guided tours for congresses, associations and study groups, as well as for tours for individual people as long as reimbursement for expenses was made.[535] The tours proved to be well attended. In 1929 Miller wrote of guards selected for each division of the museum as being "selected from people who had previously worked in that domain, and their knowledge is extended by continuing contact with the museum's advisors for the division including attendance at their presentations and lectures"; this policy may have characterized the early years of the museum as well.[536]

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[532] Miller, *Technische Museen Als Stätten Der Volksbelehrung*, 3.
[533] Linde, "Geschichte Des Deutschen Museums," 13.
[534] Fuchs, "Zur Entwicklungsgeschichte Der Physikalischen Abteilung Im Deutschen Museum," 549.
[535] Linde, "Geschichte Des Deutschen Museums," 14.
[536] Miller, *Technische Museen Als Stätten Der Volksbelehrung*, 14.

There were over 40 divisions of the Deutsches Museum, making it truly a museum of national importance. The divisions featured German artifacts where possible. For example, in 1908, the Deutsches Museum opened its Flight Division. In the first year of the new division's existence, it included among its German artifacts the original glider of Lilienthal and a model of Zeppelin's airship.[537]

The mission of the Deutsches Museum initially included the furtherance of historical research. Dyck was very clear in 1903, mentioning it twice in his Munich Technical College rector's speech outlining the purpose of the Deutsches Museum, that its initiatives would include such research to go along with the display of the collection items, as a corrective to the potential loss of a rich sense of the past through the rapidity of scientific/technological advance. The collection was intended to be "a source of historical knowledge for scholars" as well as to inform a lay audience.[538] For its part, in 1907 the German Society for the History of Medicine and Natural Sciences in its *Communications* called for its members to avail themselves of the museums's various materials in order to conduct historical research, underlining that the museum could serve specialists as well as the general public.

> For the promoting of the highly laudable project [of the Deutsches Museum] it appears important to us, that use in wider extent be made of this privilege [of a reduced yearly subscription rate for the Society members], all the more as our members by their joining reinforce the possibility, at this uniquely large-scale collection point of first-class material on the history of the natural sciences, in its library, its archives and its letters- and design-collection, that for the foreseeable future they will find open doors for their researches (*wissenschaftlichen Studien*).[539]

The same year, Conrad Matschoss underlined "[w]hat a mass [*Unsumme*] of intellectual work is embodied in all these thousands of machines and apparatus which, plainly ordered, enriched through short, informed [*sachgemässe*] descriptions, illustrations and pictures, invite the visitor

[537] Anonymous, "Bericht Über Die Sechste Ausschusssitzung," 27.
[538] *Führer Durch Die Sammlungen (Deutsches Museum)*, 4.
[539] *Mitteilungen zur Geschichte der Medizin und der Naturwissenschaften* 6 (1907).

to *study*" [italics added].[540] In 1910, the museum directorate and its advisory council announced their intention that the museum, using its own resources, would publish scientific biographies and original documents, presumably of great German scientists.[541]

However, Miller conceded in the same year that for the time being, the production of any historical research funded by the museum needed to be put off, given the financial needs of the construction of a new museum building.[542] In fact, the sole volume produced at the museum using its research materials before the 1930s was Dyck's comprehensive work on the inventor Georg von Reichenbach, enriched by the consideration of the Reichenbach instruments housed at the museum. The biography of Reichenbach was also pertinent to the Deutsches Museum because of his instrument workshop's location in Munich.[543]

It is not surprising that the Deutsches Museum served as a pattern for other museums, a fact of which Miller was proud.[544] Miller expressed, and Wilhelm Exner acknowledged, the latter's debt in starting the Viennese Technical Museum of Industry and Trades, from its founding in 1908 to its opening in 1918, not only to the ideas of the Deutsches Museum, but to the active consultation from it that he received. Exner referred to the "colossal importance" of the museum in Munich and interpreted the Viennese museum's mission as being to enhance what the Deutsches Museum did by presenting the development in Central Europe of the trades into industry.[545] As early as 1909, the director of the Paris *Conservatoire*, speaking as an invited guest at the annual

[540] Matschoss, "Ein Besuch Im Deutschen Museum in München," 976.
[541] Anonymous, "The Work of G. Von Reichenbach," *Nature* (1913): 131-32.
[542] Osietzki, "Die Gründung Des Deutschen Museums: Motive Und Kontroversen," 68.
[543] Franz Maria Feldhaus, *Die Technik Der Vorzeit, Der Geschichtlichen Zeit Und Der Naturvölker. Ein Handbuch Für Archäologen Und Historiker, Kunsthändler Und Antiquare*, Engelmann (Leipzig1914), 1302.
[544] Fuchs, "Der Aufbau Der Astronomie Im Deutschen Museum 1905-1925," 59.
[545] Anonymous, "Bericht Über Die Sechste Ausschusssitzung," 29.

meeting of the Deutsches Museum, said: "In less than six years you have come to equal and even sometimes to surpass the museum of the *Conservatoire*…"[546]

When in 1925 the museum moved into its purpose-built quarters, it achieved its full-blown destiny as a focal point for the German pride in science and a widened access to an understanding of science. But the roots had been effectively laid during the German Empire. The German Empire had obtained an institution that rivaled and in many respects outdid the South Kensington Museum Division of Science and arguably the French *Conservatoire* even before moving out of its provisional housing. It was a monument to the importance that science had assumed by the end of the nineteenth century in Germany, and also to German history. The German bent towards history was in full display at the Deutsches Museum. Its greatest importance was as a national institution. While the Germanisches Nationalmuseum as a national institution through its science divisions had shown that patriotic ardor for the new nation could be aroused through the exhibition of science, the Deutsches Museum was a more ambitious project that fully engaged all layers of the nation and showed that the Germans were intent on showing their support for an institution that very soon after its opening showed its capacity to represent all Germans. In doing so, they came together into the network of people whose basis of association was their involvement in the history of science.

TREPTOWER OBSERVATORY MUSEUM

A permanent exhibition highlighting history of astronomy added to the list of exhibitions which further served in the stitching together of a network of those who attended to the history of science. The Treptower Observatory Museum came into existence near the turn of the twentieth

[546] Ibid.

century, taking advantage of the vogue for astronomy that was surging not only in Germany but elsewhere.

In 1896, the Berlin Industrial Exhibition was a significant national event that occurred in the wake of successive unrealized attempts to launch a German world's fair. One of its most conspicuous elements was a huge telescope. This telescope was, at 35 meters' length, for its time the world's longest moveable telescope tube. Simon Archenhold, an astronomer, had been both the designer and the promoter of the building of this telescope--among other reasons, certainly, to forward German precedence in astronomy--and he was successful in eliciting the large funding needed to construct it.

Archenhold obtained permission, after the close of the 1896 industrial exhibition, to continue to rent both the public property and the building in which the telescope was mounted. His purpose was to found a Treptower observatory around the telescope and to give anyone with the wish for it the chance to do some astronomical observation and learn about astronomical topics. Within the same year that the observatory was opened, Archenhold began an astronomical museum within the building. The museum was partly but not exclusively devoted to astronomical history; that, actually, was only one of its six divisions.

The public found within the observatory's museum a good deal of information about the results of contemporary astronomical research. The museum contained a collection of wall charts, demonstration devices and objects.[547] Among the resources included at the observatory museum were *demonstrations* of how to study the heavens. But the museum was an important historical resource as well. The museum and the observatory library and archives were developed continuously, with the library regularly increasing its holding of historical materials.

[547] Dieter Herrmann, *Friedrich Simon Archenhold Und Seine Treptower Sternwarte*, vol. 65, Vorträge Und Schriften Archenhold-Sternwarte Berlin-Treptow (Berlin-Treptow: Archenhold-Sternwarte, 1986), 18.

Archenhold had to rely on his own resourcefulness in getting people to pay to come to the observatory or to receive its journal. As a private people's observatory, though, Treptower did amazingly well. Already in 1897 roughly 23,000 visitors made their way to it. In 1899, this number had gone above 60,000. There were tours through the museum daily from 2 to 5 p.m. The observatory library as of 1906 included books, special publications and regular publications of observatories and scientific societies and totaled 6500 pieces including rare old works of astronomical world literature and other historical materials. Of these 24 were sixteenth century, and those dating up to 1700 totaled 121. By 1918 the library had 25,000 items.[548]

There were multiple aspects to the Treptow Observatory. The visitors were able to hear lectures with projected images, scrutinize materials in the library and archive, and observe with the large telescope. In the museum there was a selection of old astronomical instruments for their perusal. Archenhold also collected engravings and photographs of the portraits of famous scientific scholars which he maintained in the archives along with posters relating to comets, and handwritten documents.[549] He introduced collections of the letters of prominent astronomers in the archive. Interestingly, the historically-minded astronomer Wilhelm Foerster, who was much in favor of the public access to astronomy, deeded his private library and correspondence to the Treptower Museum, evidencing that he had a high regard for the value of a separate astronomical museum (he could have deeded them to the more general Deutsches Museum).[550]

In 1906, the Observatory, after an intense public fund-raising by the organized Friends of the Observatory, was able to move into an expanded and purpose-built facility. This testified to the determination of Archenhold and to the viability of his enterprise. In a 1907 talk before the

[548] *Sterne Über Treptow - Geschichte Der Archenhold-Sternwarte* (Berlin-Treptow: Archenhold Sternwarte, 1986), 18.
[549] Herrmann, *Friedrich Simon Archenhold Und Seine Treptower Sternwarte*, 37-38.
[550] Anonymous, *Treptower Historische Hefte* 3 (1986).

History of the Natural Sciences and Medicine Section of the Scientists and Physicians meeting, Archenhold outlined the group of collections, historical in nature, that he had developed at the Treptower Observatory museum: first, astronomical instruments; second, historical pamphlets, either original or copied, on the appearances of comets; third, a collection of the portraits of famous astronomers; finally, an archive of the letters of scientific scholars. Archenhold mentioned writings on comets and other astronomical handbooks and broadsides about planets of which, in original and copy form, the museum, he told the audience, had many fine examples.[551]

The Treptower Observatory's giant telescope was a Berlin landmark. A significant part of the Treptower site's ambit was historical. Its visitors could not only get a sense for the excitement of astronomical discovery but learn about the progress of its science in earlier times. Treptower Museum added to the number of places during the German Empire where the Germans could deepen their sense of their nation's historical role in science, to go along with their pride in what it was currently accomplishing scientifically. Increasingly, they got exposure to a centuries-old scientific tradition. The central interests in science and history in the nineteenth century German lands came together in helping the Empire's population experience their new nation as one remarkable both for its present and its past, and Treptower Observatory with its museum and archive helped produce this effect particularly among the population of Berlin with regard to past German astronomical work. In addition, with its extensive historical holdings, the library was a rich resource for scholarship in the history of astronomy.

[551] Friedrich Simon Archenhold, "Geschichtliches Aus Dem Astronomischen Museum Der Treptow-Sternwarte," in *79. Versammlung der Gesellschaft deutscher Naturforscher und Ärzte zu Dresden 15.-21. September 1907*, ed. Albert Wangerin (Dresden: F. C. W. Vogel, 1907), 89.

LIEBIG MUSEUM

The Liebig Museum in Giessen, planned before the First World War though not opened until 1920, was another example of a German Empire undertaking mounted to the honor of past German science, in this case its chemistry. Justus von Liebig had been an international figure, possibly the nineteenth century's most accomplished in the combination of his chemical research and his training of a generation of chemists. It was not surprising that during the German Empire the interest grew in setting out for inspection a representation of his laboratory along with some of his scientific implements and personal effects. Showcasing in this way the achievements of Liebig, as one of the prototypical nineteenth century German scientists, was both an assertion of German national prominence and a mark of science's importance in contemporary life generally.

In 1898 in Giessen a tentative idea for the disposition of the facilities of the Liebig property in Giessen for public use was vetted by a Darmstadt chemist in a German chemical journal. The idea of a Liebig Museum was taken up by a psychiatrist in Giessen with corresponding explication and sketches. Several renowned chemists joined their deliberations to the project in 1903. The government of Hesse lent its offices to negotiations. The Association of German Chemists also declared its intention to set up and maintain a Liebig Museum, if the grounds and property were given to it.[552]

In 1904, a supporter of the plan for the setting up of a Liebig-Museum in Giessen which would illustrate the history of chemistry called for "our great Liebig's" letters and apparatus to reside in Giessen, noting that a Dr. Marquart had given some of Liebig's letters to the Deutsches Museum, and had put in prospect to give some of Helmholtz's and Liebig's apparatus to the Deutsches Museum. In spite of his otherwise enthusiastic support of the Deutsches Museum, he

[552] Adolf Kohut, *Justus Von Liebig: Sein Leben Und Wirken Auf Grund Der Besten Und Zuverlässigsten Quellen Geschildert* (Giessen: Emil Roth, 1903), 377.

considered that all admirers of Liebig would be distressed to find that any artifacts associated with him had been incorporated at another site. Just as Berzelius had his museum in Stockholm, so should Liebig's be in Giessen. This discussant invoked the Hessian Ministry, the University, and the city of Giessen to put their support behind the founding of the museum there.[553]

The Deutsches Museum did not prevail. By 1909 a further invocation to turn the Liebig laboratory into a museum led to the constituting of a commission to act on the matter. The Grand Duke of Hessen assumed the protectorship of the initiative. Liebig family members, friends, and former students donated auxiliary paraphernalia pertaining to Liebig.[554]

Exterior improvements had been brought to completion at the start of the First World War. Advances to bring the interior into its final form were ongoing throughout the war. The potash oven was restored. Many of the original Liebig apparatus and utensils were laid out, and designs for certain others allowed reproductions to be made. Writings, books, letters and Liebig personal memorabilia were donated. Most of the laboratories, the lecture room, Liebig's working space and his private laboratory were united into the museum.[555]

Although this institution was only "in the works" during the German Empire and first opened to the public just after its downfall, the plans and activities extending over a period of more than two decades for a Liebig Museum certainly promoted local Giessen pride and, because the appeals for monetary support that went out to chemists, other scientists, and the public were successful, there was also a stake for Germans generally in the preservation of the site. Similarly to the memorials to past scientists, which current representatives of one or another science spurred and helped to fund, the German chemists were poised at the ready to give honor

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[553] Anonymous, "Über Die Pflege Historisch-Chemischer Studien Und Das Liebig-Museum," *Chemiker-Zeitung* 28, no. 1 (1904): 354.
[554] "Liebig Museum: Chemiemuseum in Giessen," http://www.liebig-museum.de/museum/geschichte/gute_und_schlechte_zeiten.php.
[555] Ibid.

to one of their own who stood in for them collectively. The participation of the government in arranging for the Liebig Museum shows that not only was Liebig important to the chemists, but that his achievements, along with those of other prominent German chemists, formed a significant part of the German claim to renown in nineteenth century science overall. The Liebig Museum promised to exemplify scientific traditions that were central in the formation of a positive image for the new German nation, and brought together people with an interest in drawing on German scientific history to achieve contemporary renown.

An additional comment on this museum's objects' "career" compared to objects at the other displays I'm considering relates again to Sam Alberti's ideas addressed in section 0.1.3. An assembly of certain old objects a particular individual used, together within the very physical structure where that person did his professional scientific work, gives them a contour not available to objects at most museums. The disconnect spoken of by Dyck when he specified that "[t]he spatial arrangement [in an exhibition] requires a cutting apart of many of the existing connections" was not entirely eliminated by their housing within their original work site, but this conformation helped the Liebig Museum retain one important connection, that of shared place.[556] On the other hand, the inclusion at the restored Liebig laboratory of some of his appurtenances that originated in his life elsewhere may have worked in the opposite direction.

FURTHER REMARKS

The historical scientific exhibitions and displays during the German Empire show a significant diversity. Displays, both temporary and permanent, of historical scientific relics were an effective way of spreading among Germans the resonance of the history of science. I have

[556] Dyck, *Über Die Errichtung Eines Museums Von Meisterwerken Der Naturwissenschaft Und Technik in München*, 24.

used them as my principal detailed evidence that Germans were active in this domain ahead of other nationals. Along with their scholarship and memorials, dedicated journals and books, and national society, I attempt using the displays and exhibitions to build the case that the German nation led the way to the early institutionalization of the history of science. A faction of the German scientists and technologists, significant beyond their small numbers in part because they could operate on the national stage, was intent to put before the audiences of their peers and the broader public the relics of past German sciences. Like national scientific associations and scientific journalism, the historical scientific displays could in their turn contribute to the development of a national public.[557]

The previous emergence in the use of a comprehensive epistemic category embracing all of natural science impressed on organizers of some German Empire historical scientific exhibitions the appropriateness of presenting the historical artifacts of the natural sciences taken together.[558] The movement towards a generally perceived notion of "the natural sciences" as an entity took place in Germany in the early and mid-nineteenth century. Denise Phillips maintains that already in the late eighteenth century there was a sense of a unified natural science but that there was simply not yet an epistemic unit to communicate it. This movement to achieve one transpired within the following fifty years, as the term "natural philosophy" that along with the term "natural history" had previously defined what constituted knowledge of natural causes and phenomena increasingly fell out of use. The term "*Naturwissenschaft*" took hold; what was covered by it was widely understood by mid-century.

The displays were held under a variety of circumstances and were of widely different scope. Some presented past German science to foreign audiences, while most were for viewers at

[557] Goschler, "Deutsche Naturwissenschaft Und Naturwissenschaftliche Deutsche," 100.
[558] Phillips, *Acolytes of Nature: Defining Natural Science in Germany, 1770-1850*, 30.

home. The combined evidence from these events shows that they constituted a worthy complement to the accelerated activity in the scholarly work on the history of science and the memorialization of scientists during the German Empire. The most frequently encountered objects at the history of science displays were the published works, due to their abundance and to the greater likelihood that books, compared to instruments, might be retained and not destroyed or taken apart, as were instruments, in order to forage their parts. But beyond the old books and other publications, the displays, along with a portion of the materials written by scholars during the German Empire, show the significant meaning that the Germans gave to the material culture of science—the instruments, maps, clocks, and even personal ephemera of scientists.

The displays, I allege, played a role in bridging differences among the Germans during the Empire. Perhaps the most obvious and telling differences among the Germans were their religious affiliations which impacted so greatly on their social and economic lives. How diverse were the affiliations of the display organizers, and did they represent in their own narratives a bridging of their religious and political differences? The majority were Protestant, in keeping with the Protestant majority in the German nation. But their common bourgeois identity may have had far more meaning in their self-identification than their religious confession. Oskar von Miller, who may have been unusual as a devout Catholic among display organizers (he was a regular attendee at Sunday mass—another Catholic was Felix von Oefele), was able to summon outstanding efforts from all denominational sectors of Germany in the service of the Deutsches Museum, and together with Walther von Dyck and Carl von Linde, both Protestants, headed it up for many years, giving an impression that in this enterprise, any confessional differences were unimportant.[559] For the three events up to 1878, August Wilhelm von Hofmann as the chief German figure for the London 1876 Exhibition, Ernst Gerland for the exhibition at the Kassel

[559] Wilhelm Füssl, *Oskar Von Miller 1866-1934: Eine Biographie* (Munich: Beck, 2005), 354.

1878 meeting of Scientists and Physicians, and Siegmund Günther for the Germanisches Nationalmuseum science division were all Protestant. The display organizer Friedrich Simon Archenhold was Jewish, so like Miller and Oefele he was an interesting outlier in terms of religion. It is interesting that both Miller and Archenhold headed up scientific displays that were expressly dedicated to the entire German people including the lower orders, and whose publicity tried to ensure that all the sectors of the population would feel welcome. There may be some significance that these two members of German religious minorities were particular advocates for an inclusive German public's access to the exhibitions they authored.

I have come across no materials suggesting that any of the display organizers investigated in this dissertation were Social Democrats, other than the fact that Friedrich Simon Archenhold was buried in 1939 in the Zentralfriedhof Friedrichsfelde, a Berlin cemetery in which a number of socialist activists had been buried from 1919—but which was also known as a national cemetery for all. While the organizers were drawn from various sectors of the German society, most if not all seem to have been members of the bourgeois establishment.

In the organization of German scientific displays during the Empire, the history of science was primarily modeled as an instrumental continuum in which more sophisticated or accurate ways to perform measurements or illustrate natural phenomena advanced through the centuries. In the displays and their documentation, no organizers thought to offer any reflection on the changes from one era to another in the perception of what science had been attempting to accomplish. For example, the inclination to further natural knowledge in confirmation of the ancients' natural knowledge was characteristic of the high Middle Ages through the entire seventeenth century.[560] But by the sixteenth century, objects were also observed and tested to

[560] Paula Findlen, *Possessing Nature: Museums, Collecting, and Scientific Culture in Early Modern Italy* (Berkeley: University of California Press, 1994), 26, 95.

attain knowledge about them for their own sake.[561] In contrast to the Middle Ages' approach to the natural world that privileged the general and the universal, the close observation of natural phenomena and objects in their particularity was already characteristic of the approach to the natural world that distinguished the fifteenth and sixteenth century non-academic writers with a natural philosophical training and of professors of medicine who introduced the practice of field trips for collecting, and by the seventeenth century, of naturalists generally.[562] The historical scientific exhibitions during the German Empire made no reference to any of these changes.

Neither did the organizers make any distinctions among the divergent epistemes that Daston and Galison identify as characteristic of the eighteenth century (truth-to-nature) and of much of the nineteenth (objectivity), nor of the shift portrayed by Paula Findlen between scientific virtuosity in the late Renaissance and Baroque periods and the less court-centered science of the eighteenth century.[563] Perhaps the implicitly closest any of the exhibitions came to a demarcation of the periods in the history of science was the inclusion in certain displays of ornamentally figured scientific instruments commissioned by the European royalty and aristocracy during the fifteenth, sixteenth and seventeenth centuries. These proofs of their command of financial resources, when brought alongside the instruments of the nineteenth century that were marked by an austerity and lack of ornamentation, contrasted the culture of virtuosity attaching to earlier scientific activity to that of the mid-to-late nineteenth century scientist anxious to practice scientific sobriety and elimination of the subjective.

A striking observation is that, in at least some display contexts, the German organizers included kinds of material remnants that pertained to magic, invocation, and non-physical

[561] Daston and Park, *Wonders and the Order of Nature, 1150-1750*, 147.
[562] Ibid., 116,. 136; Lorraine Daston and Peter Galison, *Objectivity* (New York: Zone Books, 2007), 67.
[563] Daston and Galison, *Objectivity*, 18. Findlen, *Possessing Nature: Museums, Collecting, and Scientific Culture in Early Modern Italy*, 15, 398.

influences, as well as ephemera. The Germans were less inclined to view suspiciously any incursion of "defective material" which might serve as a lure for the public just because of its seemingly bizarre nature. By no means did this mean that the Empire Germans were not dead-serious about their contemporary scientific achievement, stripped of any accoutrements of the bizarre. Can an inclusion in some contexts of these oddments in a narrative of science be reconciled with this dissertation's claim that Empire Germans set in motion the early disciplinary formation of the history of science?

The issue is salient because, as the center of the discipline shifted outside of Germany in the post-World War I period, such leading non-German personalities as George Sarton, founding editor of *Isis*, called for an austere exclusion of items smacking of superstition from any place in the history of science's narratives and collections. In the ongoing discipline, the German penchant for an inclusion of such items was being superseded and would not reappear again in such prominence. But even Sarton, commencing *Isis*'s annual bibliography in 1919, included a section titled, "*Science et occultisme, histoire des sciences occultes, histoire de la sorcellerie*" ("Science and the occult, history of the occult sciences, history of sorcery".)

There can be at least two responses to these demurrals from according to the German Empire the discipline's early institutionalization. First, the contexts in which Germans wished to emphasize their civilizational advances, for example the world's fairs and the electrotechnology expos, did not give any place to objects of magic and incantations—far from it. They wished to emphasize the German technical skill and the deep German penetration, on a rational basis, into the secrets of nature. Even the seeming counter-example of the St. Louis World's Fair's inclusion by Germany of an alchemist's chamber does not refute my assertion, because certain technical chemical knowledge resulted from alchemy. Rather, it was more at the cultural-

historical types of German showplaces that such items were included, where even the less-enlightened past found a place. The Germans took more account of science's history as heritage compared to other nations, slightly later, which emphasized the process of scientific deduction and experimentation as an intellectual quest not to be diluted or contaminated with any pre- or non-scientific beliefs and behaviors.

Second, it is possible in my view, given the jump that the German Empire had on other nations in giving a structure to the discipline of the history of science, that had there not been the national disasters of war twice and their aftermaths of scarcity, the German precedence in the field would have continued for some while, perhaps bringing a somewhat different cast to what could be counted as the history of science than that which was generally widely accepted beginning in the 1920s, as other nations took the lead. In the main, Germany's beginnings of institutionalization of the discipline of the history of science continued elsewhere without any significant reconfiguration. In the one instance of the sharply diminished acceptance post-Empire of the cultural-historical dimension in the narratives of science's history, the trajectory of what the discipline was becoming underwent a real change. Considering all the other ways in which these Germans provided structures for the discipline to further build on essentially unchanged, I maintain that this does not fatally operate against my contention that the Empire Germans deserve the credit for taking the early steps of the disciplinary formation.

Such considerations lead into the broader question of the extent to which the German historical scientific displays and exhibitions were intended by their organizers to serve as instructional and educative, beyond being merely informative or entertaining. Some organizers seem to have been aiming at the registering, writ large, by the visitors to their displays of the extent of the historical past of science, or of a particular science. The mere selection of the

objects to offer gave some clue as to what the organizers intended. For example, the 1898 Düsseldorf exhibition massed together objects spanning the past three millennia, and embracing different cultures. Perhaps the idea was that in this flood of impressions, something or other might catch the attention of any one visitor as particularly interesting. But he or she would surely be impressed that science and medicine of some description had accompanied mankind for so long. Essentially all the exhibitions also testified, by the preponderance of their Middle Ages and modern items of German provenance, to concentrate their visitors' attention on the contributions of Germans to science, or in the specific cases of pharmacists and geographers, of the renown attaching to their own past. And even the intention of some organizers to bring before the visitors to their displays actual iconic exemplars, belonging to renowned scientists or used in highly significant researches, while discarding old scientific items that lacked pedigrees or that weren't part of a sequence illustrating the development of apparatus used for a particular purpose, was evidently driven by their wish that the *importance* of science register strongly.

Some exhibitions also aimed to not only get a response from their visitors, but a measure of understanding of the basis for scientific findings. The comment cited earlier of Franz Fuchs as to the inadequacy of an undifferentiated conglomerate of display objects testifies in this regard. The directors at both of the national institutions represented here, the Germanisches Nationalmuseum and the Deutsches Museum, stated the didactic aims of their institutions. August von Essenwein at the former pointed up the historical scientific exhibition's admixture of instruments, graphic arts objects, and library items to ease any sense of a fragmentation among visitors. Oskar von Miller at the Deutsches Museum maintained that it ought to provide *Volksbildung* [the improvement of the level of the common people], a view seconded by the

writer on engineering history Conrad Matschoss already in the museum's second year of operation. Matschoss elaborated that it was a site

> which is adapted [*geeignet*], as no other place is, to also give to the laiety a conception of the premium intellectual work which resides in the creations of natural science and engineering. But the museum wants also to impart…a visual instruction for the working people. The visitor should not only be amazed by, but should understand, that which is seen [*das Beschaute*]. In the whole arrangement of the collections, in the manner of the explicatory notices and illustrations, in the cross-sections of the machines and the apparatus, in all the many models which can be [visitor-] operated in the most varied ways, the caring wooing [*liebevoll werben*] of the visitor's understanding expresses itself.[564]

Miller's years-long special assistant and curator Franz Fuchs referred to another scientist's view of the "genius" of Miller's plan to perform "popular education" (*Volkserziehung*), which Miller undertook first of all with astronomy (the museum's section which had the first guided tours) because it was a subject of current widespread popular interest. It was, in Fuch's words, Miller's desire that this be a "people's observatory" (*Volkssternwarte*) in which the German man, woman or child on the street would be able to view the cosmos and carry away some understanding of the goals of astronomy and of the significance and interest of tracking the activity of the various heavenly objects. Later, after the end of the German Empire, as Miller sought to re-energive the museum, he had a massive new observatory built within it, pursuing the same aim of giving the average visitor more insight into astronomy.[565]

In one of Miller's exchanges with an observatory director, Fuchs indicated, Miller did not discount the "thirst for knowledge" (*Wissbegierde*) of the German people at large, and even in some instances rather valued catering to the public's curiosity more highly than simply informing it.[566] Sensitive to the effect of position on perception, he had the historically most important instruments put at the most prominent locations at the museum. However, he was

[564] Matschoss, "Ein Besuch Im Deutschen Museum in München," 82.
[565] Fuchs, "Zur Entwicklungsgeschichte Der Physikalischen Abteilung Im Deutschen Museum," 550.
[566] "Der Aufbau Der Astronomie Im Deutschen Museum 1905-1925," 30-31.

always attuned both to the historical worth of the original exemplars and to the educational potential of the displays, original and otherwise. As Fuchs related, "the repeated explications by the room attendant [about a luxurious Gothic astronomical art clock on display at the museum]…gave instruction to many visitors on the division of time, the constellation of the planets and the movement of the heavens," and Miller consistently maintained a close supervision of such museum personnel.[567]

A number of the exhibitions made it a point to offer for viewing *ordered lines of development* of apparatus; the implication was that through this exposure even a non-specialist might gain some clues as to the operation and refinement of the instruments used to acquire certain kinds of data. Certainly at the Deutsches Museum, then, but also at least at certain ones among the other exhibitions, their organizers intended more than to put on a show; the organizers wanted their visitors to gain some understanding of the historical achievements of the sciences and the development of their apparatus over time.

I also consider that the Empire scientific organizers intended to transmit one or more ideological messages through the events they put on. Particularly at the international sites, and no less at the national museums, but to a good extent at almost every exhibition, the message was clear: German science, in the past as well as the present, deserved the highest esteem, and on a larger scale, Germans were a powerful people with a rich history of civilized institutions and achievements who deserved a place among the leading peoples of the world. The ideological thrust here was somewhat different from the message conveyed by the prominent British engineer J. Scott Russell during a talk he gave at the 1876 Special Loan Collection, when he referred to "the marvelous progress of science during the century in which you and I have the

[567] Ibid.: 15. "Zur Entwicklungsgeschichte Der Physikalischen Abteilung Im Deutschen Museum," 549.

good fortune to live and work."[568] Russell, consistent with the announced non-national aims of the London event, was primarily pointing up the high stature of contemporary science as an aspect of civilization, without reference to national ranks or differences. German Empire organizers, on the contrary, generally saw no need to dispense with a national coloration in the displays they subsequently staged. A further ideological message intended by Miller, according to Fuchs on the occasion of the celebration of the centenary of Miller's birth, was that science was qualified to serve, for the lay person, as a source of spiritual elevation, akin to the sublime cultural enhancement offered to the public by artistic works of great merit—and certainly with its many German masterworks, the Deutsches Museum would offer its elevation primarily to the Germans and primarily through the channel of the German scientific achievements.[569]

The exhibitions organized by the Germans had influence abroad in some instances. The Germanisches Nationalmuseum Pharmaceutical Central Museum became a model for similar facilities in other lands. Once in its new facility in 1925, if not before, the Deutsches Museum was hailed as a world-class institution and was exemplary for other general scientific museums. In 1929 Miller wrote that "in Japan, Sweden, Russia and especially the United States our type of museum will be built and a few are already underway. I will assist them with advice and co-work."[570] But already in 1909, nine years before its opening in 1918, a Technical Museum for Industry und Trades in Vienna leaned heavily on the expertise of the Deutsches Museum conveyed through Oskar von Miller. And by that year, the Deutsches Museum was in cooperative exchange with the *Conservatoire des art et métiers* and the Science Museum, and even invited the director of the *Conservatoire* to its annual meeting.[571] Reconstruction of an

[568] Chisholm, "Standard Weights and Measures," 493.
[569] Fuchs, "Zum 100. Geburtstag Von Oskar V. Miller ": 217.
[570] Miller, *Technische Museen Als Stätten Der Volksbelehrung*, 17.
[571] Anonymous, "Bericht Über Die Sechste Ausschusssitzung," 30.

alchemist's chamber, shared by three different sites in Germany, was also done in 1898 at the festivities celebrating the fiftieth birthday jubilee of Austro-Hungarian Emperor Franz-Josef.

Perhaps the scientific history displays organized by the Germans had their greatest influence on one another, as the 1893 German Mathematical Exhibition consciously emulated the 1876 London Exhibition in whose aftermath Ernst Gerland's report had documented its historical aspect (including though not limited to German display items) in the absence of any British counterpart, as the Deutsches Museum attained a library, archive and house publications like those of the Germanisches Nationalmuseum, or as the Kaiserin-Friedrich Haus exhibition took some of its inspiration from the 1898 Düsseldorf exhibition. There was some duplication of organizing personnel among the various temporary and permanent sites of display in Germany in this period. Ernst Gerland, who beyond authoring material on the 1876 London exhibition's historical element did so as well on the Kassel Museum collection in the 1870s, served in the Deutsches Museum as specialist for its Weights section. Walther von Dyck, who organized the 1893 German Mathematics Association display, was one of the three people on the directorate of the Deutsches Museum for over twenty-five years, serving as the head of its archive and writing for the museum its sole archivally-based scholarly work during the German Empire. Karl von Sudhoff, besides being co-organizer of the 1898 Düsseldorf exhibition, contributed to writing the catalogue for the 1906 Kaiser-Friedrich Haus exhibition. And the twenty-fifth meeting of the German Geographer's Society, in 1907, which had been having historical exhibitions, also incorporated a talk by Gustav von Bezold of the Germanisches Nationalmuseum on his museum's scientific collection.

As for lasting influence in printed form, as mentioned, the catalogue of the 1893 Munich mathematics exhibition has been reprinted in 1994. The catalogue of the 1891 Frankfurt electricity exhibition was also reprinted, in 1991, as a centenary edition with a new introduction.

Displays formed a significant part of the German contribution to the early institutionalization of the history of science, despite the temporary nature of some of them. They extended the network of those with a stake in this domain of knowledge. They reached beyond the rather restricted circle of those who would consume the products of the history of science scholarship to engage a more general public, just as the memorials to scientists did. They included in some instances the features of popularization—their overall intent was to provide both instruction and rational entertainment, consonant with the important role contemporary science, but also increasingly past science, were coming to have in the national imaginary. While the memorials raised the public awareness of and esteem for the scientific figures of the past, the German historical scientific displays broadened the group of citizens who obtained a concrete image of the scientific deeds that they had performed and of the apparatus that they had used. All this was useful in securing the national self-image.

Before we deduct too much from what the Germans achieved in their historical scientific exhibitions, it is instructive to compare what was done at the premier scientific historical sites in Britain and France. The South Kensington Museum's science collections functioned as a sort of national exact sciences and technology museum in the aftermath of the 1876 London exhibition. All efforts to found a separate museum for science ran into financial difficulties, as well as active lobbying against it by some who felt that the figures supporting the prospective museum were a self-interested clique at the head of which stood Norman Lockyer, the editor of *Nature*. A

thoughtful if wry observer, the political economist Stanley Jevons, was unimpressed by the scientific collections at South Kensington in 1881:

> The worst possible conception of the mode of arranging Museums is exemplified …I passed on only to find myself among certain ancient machines and complicated models…I fell among an extensive series of naval models, with all kinds of diagrams and things relating to them…the mental impression is that of a nightmare of incomprehensible machines, interminable stairs, suspicious policemen, turnstiles…[572]

To boot, the mission of the science collections at the South Kensington Museum was not entirely clear. In 1897 a Select Committee insisted that "[t]he museum should be primarily educational and discretion should be exercised to prevent an undue proportion of historical over effective exhibits."[573] And through the 1920s, there was a downplaying of the historical at the South Kensington Museum.

Likewise, the verdict could be very harsh of the Parisian *Conservatoire des arts et métiers* which, operating from the early nineteenth century, was the earliest national museum of science and technology. In his 1925 book on industrial museums, Charles Richards deflated the *Conservatoire*:

> From a museums standpoint the value of the *Conservatoire* rests entirely upon its very extensive collection of models of tools, machines, apparatus, and industrial buildings...no educational principle seems to have guided their selection. The significant invention or forward step is lost in a mass of material...no…progressive steps are arranged in series. Scarcely any explanatory matter in the form of representations, drawings, diagrams or labels has been used...A few of the models can be operated electrically, but the proportion is very small…The educational possibilities are not developed…today it is merely a great storehouse.[574]

Given the sometimes harsh strictures on these two national institutions, it can be said, first, that their counterpart the Deutsches Museum succeeded in its aim to model itself after

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[572] William Stanley Jevons, "The Uses and Abuses of Museums," in *Methods of Social Reform, and Other Papers* (London: Macmillan, 1883), 59-60.
[573] Anderson, "Connoisseurship, Pedagogy or Antiquarianism: What Were Instruments Doing in the Nineteenth-Century National Collections in Great Britain?," 224.
[574] Richards, *The Industrial Museum*, 10-11.

them, but to also be different. Even in its provisional quarters occupied in 1906, the Deutsches Museum was such as to invite a favorable comparison with its counterparts. Its organization was much tighter and more thoughtful.

The Deutsches Museum, along with some other German exhibitions, used an approach intended to highlight the lines of instrumental development. Such an approach was intended to be strictly educational. Developmental series were also introduced at the Dresden collection, the 1893 German Mathematicians Association exhibition, the Pharmaceutical Central Museum and the Kaiserin-Friedrich Haus, as well as at the 1885 German Geographers Society exhibition and at the German mathematical models display at the Chicago World's Fair. These efforts would have stood up very well beside the arrangements found in London at the South Kensington Museum and in Paris at the *Conservatoire*.

CONCLUSION

This chapter, along with the prior one, has been devoted to documenting the specifics of the displays of scientific relics during the German Empire. They have attempted to demonstrate that the displays collectively were a significant and revealing phenomenon, opening the door to a further discussion in the three subsequent chapters of why these events happened where and when they did. I will contend that the rise of German science, the historical consciousness among Germans, the cultural influence of the bourgeoisie and, tied most particularly to the period of the Empire, the new nation's need for a "heritable past" all set the stage for the phenomena of these two chapters, as well as the other aspects of the German Empire early institutionalization of the history of science supplied in Chapter 1.

Some testaments suggest that a majority of the nineteenth century German scientists spent little time concerning themselves with the scientific past. Siegmund Günther, whom we have met often in these pages as a scientist-historian, said in 1876, "[o]ne should generally be happy, in the case that he has learned to regard historical studies as sheerly superfluous, and not also as precisely harmful."[575] Theodor Puschmann, a German pioneer in history of medicine, said revealingly in 1889:

> The fruitful vitality of research activity that arises here [in German-speaking lands] and which with hastening zeal brings to light new findings daily prompts the thought that the present is everything, [and] the past…nothing… Dissatisfied with the encyclopedic tendency of mind which ruled in the eighteenth century and later in German lands emerged in the guise of *Naturphilosophie*, researchers cast off from their historical tradition...The few physicians and scientific researchers who have maintained the sense for historical studies and are active in this sphere, appear to the great majority of their fellow practitioners as strange, as curiosity-bundlers, for whose strivings one feels a disdain leavened only by pitying sympathy.[576]

Even in 1898 professor of ophthalmology Friedrich Helfreich told a similar tale of the challenge of fostering scholarship in history of science: "…the uninterrupted course of the development of natural science and medicine has suppressed the inclination for historical studies in this area." In 1898 Sudhoff expressed dismay that "[s]till the muse of History is seldom invited as a guest to the gatherings of German physicians and scientists; never yet has so much attention been bestowed on her as at this rejoicing-meeting...May...the history of our disciplines become the constant companion of research."[577] But he hinted at a nascent change: "Bravely and diligently our troop [who investigate the history of science in Germany] has moved on from the

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[575] Siegmund Günther, *Ziele Und Resultate Der Neueren Mathematisch-Historischen Forschung* (Erlangen: Eduard Besold, 1876), 1-2.
[576] Theodor Puschmann, "Ueber Die Bedeutung Der Geschichte Für Die Medizin Und Die Naturwissenschaften," *Wiener Medizinische Blätter* 12, no. 39 (1889): 614; Günther, *Ziele Und Resultate Der Neueren Mathematisch-Historischen Forschung*, 1-2.
[577] Sudhoff, *Historische Ausstellung Für Naturwissenschaft Und Medicin in Den Räumen Des Kunstgewerbe-Museums: Düsseldorf, Juli-October 1898 (70. Versammlung Deutscher Naturforscher Und Ärzte Zu Düsseldorf 1898)*, i [no actual pagination].

before so often stony and thorny roadway."[578] These comments all indicate that the struggle to implant more involvement with science's history was an ongoing one. In the gradually and tentatively emerging field it was, nonetheless, the Germans who moved ahead most decisively.

The rise of science, now in the nineteenth century playing a key role in general culture, brought about a reflection on its past. The Germans were the most active people in driving scientific research forward. Not coincidentally, a select group of the Germans became the chief early exponents of the history of science as the field first began taking shape in the form that we would recognize today. Both the temporary displays and the permanent exhibitions of the history of science organized by the Germans were a powerful incitement to its practitioners and to the general public to accord respect, and in some cases to participate in activities relating, to the history of science. Some of those who organized the displays also performed scholarship in the field. Such figures firmed the backbone of a network getting underway that would support the further institutionalization of the history of science.

[578] Helfreich, "Medicinisch-Historische Ausstellung 70. Versammlung Deutscher Naturforscher Und Ärzte," 1570; Sudhoff, "Aus Der Vorgeschichte Unserer Gesellschaft: Ein Rückblick," 1; See also Karl von Sudhoff, ed. *Historische Studien Und Skizzen Zu Naturwissenschaft, Industrie Und Medizin Am Niederrhein: Der 70. Versammlung Der Deutschen Naturforscher Und Ärzte Gewidmet* (Düsseldorf: Müller, 1898), i [no actual pagination].

PART II:

THE FACTORS LEADING TO THE GERMAN EARLY INSTITUTIONALIZATION OF THE HISTORY OF SCIENCE

In Part I this dissertation has addressed the German involvement in the various manifestations of the activity in the history of science. In Part 2 it searches out what I consider to be the chief factors within the German way of life and the social developments that predisposed Germany during the period of the Empire to take the lead in creating an institutional framework for the field of the history of science, as outlined in the introduction. These are the rise of German science, the penetration of a historical consciousness among the Germans, the importance of consolidating a German national identity, and the cultural and intellectual preeminence of the German bourgeoisie.

CHAPTER IV:

GERMAN POLITICS, SOCIETY, ECONOMY, RELIGION AND INDUSTRY

To initiate Part 2, Chapter 4 will discuss overall nineteenth century German politics, society, economy, and industry as a means of contextualizing the events in the German lands pertaining to science, including those in the development of the history of science. This will be followed by two chapters treating the first two factors above in more detail. The third and fourth factors are woven in to Chapter 4 and elsewhere. Aspects of nineteenth and early twentieth century German history with a bearing on science highlighted in this chapter include the imprint of Napoleonic subjugation and the liberation from it, the generally increasing economic and social importance of the bourgeoisie, the 1840s upsurge of the liberal forces aiming at a representative government, the increase in the German industrial capacity from 1850, and the installation of a unified Germany in 1871 still disjoined by multiple divisions and at times unsure of its identity but attaining a world-power status. The sources used are varied and include general histories of Germany, treatments of particular aspects of German life, and contemporary nineteenth and twentieth century testimonies.

THE LONGER-TERM HISTORICAL BACKGROUND

Centuries before the unification, there had been a German *Kulturraum* (cultural sphere) that gave the German lands an imprint of commonality despite their political fragmentation. The Holy Roman Empire, a loose aggregation of locally-based authorities which dates from 962 A.D., represented Europe's feudal order of the Middle Ages. The Empire was headed by a single Emperor, ostensibly performing a continuation of the rule of the classical Roman emperors, but

in fact elected by "subject" princes.[579] The largest among the Holy Roman Empire's constituent territories after 962 were made up of the German lands.

This political formation lasted eight hundred years. The history of the German lands preceding the nineteenth century was tied up with their location in the center of Europe, unprotected by natural land forms, and by the persisting presence of some elements of the old feudal order of Europe. During this extent of centuries, but weighted towards the Holy Roman Empire's latter four centuries, German lands had many achievements and watersheds, including very old universities, impressive scientific accomplishments, legal codes, the spearheading of the cultural breakthrough of printing, and the impetus to the Christian Reformation.

However, the Thirty Years' War of 1618-1648, an all-European conflict in terms of the nations participating, had a particularly horrific impact on the German lands, in which the majority of the fighting was done. In addition to a German population loss of twenty percent, there was homelessness, devastation of arable territories and a generalized disruption of civil life.[580] And subsequent to this traumatic happening, the persistence of an extreme political fragmentation and of a poorly centralized, partially feudalized structure meant that the German lands did not keep up with the social, economic, or scientific developments in places like England and France. Some eighteen hundred German political units of at least a semi-sovereign character existed, many of which were sharply limited in size, and therefore seemingly vulnerable to consolidation within larger units.[581] By the end of the eighteenth century, as the Holy Roman Empire faltered into its last years, some individuals within the segment of the middle class with superior educational credentials already promoted the idea of a unified German nation, but little development of a network of institutions bringing together various German

[579] Schnabel, *Deutsche Geschichte Im Neunzehnten Jahrhundert -- Die Grundlagen*, 143.
[580] Sheehan, *German History, 1770-1866*, 74.
[581] Eda Sagarra, *Germany in the Nineteenth Century: History and Literature* (New York: P. Lang, 2001), 1.

lands had occurred.[582] In the realm of scholarship, the trend was toward a nascent nationalism: the transition in publications and oral presentations in Germany from the usage of Latin to local languages was already far advanced *before* the first half of the nineteenth century. Science was part of the trend of knowledge in all fields in German lands receiving this national imprint.[583]

UPHEAVAL

The European monarchical order was shaken by the French Revolution, begun in 1789, and when an army of citizens of the newly-minted French Republic advanced eastward in 1794 under Napoleon, rulers of the German lands had reason to fear for the survival of their reigns. He reworked the power balance in Europe, including in German lands. As a general and then as the Emperor of the French, Napoleon brought far-reaching changes to many polities that he subdued. The German state-order of most of the nineteenth century, and eventually the formation of a unified Germany, would have taken on a far different profile had not virtually all the German lands at the start of the century come directly or indirectly under the influence of Napoleon's might. The aim of rational management and the subjugation of all other considerations to financial ones were characteristic of the bourgeois spirit of the Napoleonic order, as were accountability and efforts to impose predictability in administration, judicial activities, and commerce.[584] In the Kingdom of Westphalia and parts of the Confederation of the Rhine, the Napoleonic Code, a reformed legal code, provided a new set of tools. This system of legal measures guaranteed the free movement of persons and of property and equality before the law,

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[582] David Blackbourn, "The German Bourgeoisie: An Introduction," in *The German Bourgeoisie: Essays on the Social History of the German Middle Class from the Late Eighteenth to the Early Twentieth Century*, ed. David Blackbourn and Richard Evans (London: Routledge, 1991), 3. Sheehan, *German History, 1770-1866*, 73.
[583] Kai Torsten Kanz, *Nationalismus Und Internationale Zusammenarbeit in Den Naturwissenschaften: Die Deutsch-Französischen Wissenschaftsbeziehungen Zwischen Revolution Und Restauration, 1789-1832 Mit Einer Bibliographie Der Übersetzungen Naturwissenschaftlicher Werke* (Stuttgart: F. Steiner, 1997), 51.
[584] Schnabel, *Deutsche Geschichte Im Neunzehnten Jahrhundert -- Die Grundlagen*, 152. Blackbourn, "The German Bourgeoisie: An Introduction," 19-20.

together constituting an integrated bourgeois legal foundation. In the process, the scattered elements of German law, drawn from a variety of origins, were rounded in these areas into a logical and precise whole more in keeping with the contemporary society.[585] A rational political, legal, and administrative order and a positive business climate, characteristic of the rise of the bourgeoisie, were generally conducive to scientific advance.

At the start of the nineteenth century, relatively few advocates in the un-cohesive German lands had staked out a position in favor of building a strong German state. But as the various German principalities suffered at the hands of Napoleon, some of the educated elite did ponder this eventuality.[586] For this select minority of the Germans, already during the Napoleonic era, a fealty to the German nation overrode all other loyalties.[587]

An essential reason why Germany during the Empire proved a favorable site for the initiation of a number of the developments in the institutionalization of the field of the history of science was the German revival movement at first linked to overcoming Napoleon's incursions. The resurrection of the German lands from their subjection to Napoleon brought with it a new spirit of progress and modernization, which soon came to be important factors in the rapid development of nineteenth century German science. The French invasion of the German lands ensured that while the German states later continued or soon introduced numerous changes for which Napoleon had provided a model, the German feelings against the French ran high during and long after the occupation. A number of the Romantic writers led the way in articulating a German ethos in opposition to a French one.[588] The popular ideas about the ties binding all the

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[585] Schnabel, *Deutsche Geschichte Im Neunzehnten Jahrhundert -- Die Grundlagen*, 137-38.
[586]Eric Dorn Brose, *German History 1789-1871: From the Holy Roman Empire to the Bismarckian Reich*, New and revised edition. ed. (New York: Berghahn, 2013), 13-14. idea taken from Heinrich Winkler in Der lange Weg nach Westen volume 1 page 39.
[587] Jonathan Sperber, "Introduction," in *Germany 1800-1870*, ed. Jonathan Sperber (New York: Oxford University Press, 2004), 10.
[588] Sagarra, *Germany in the Nineteenth Century: History and Literature*, 6.

Germans were critical to the passage in a period of fifty-five years from the weak, divided lands subject to Napoleon to an Empire. Among the generation from which the liberators were drawn who later became scientific leaders, the physicist Franz Ernst Neumann stands out for his willingness to endure hardship and penury both for the German people and for science. Contemporaries considered him to be representative of the Liberators' patriotism and idealism.[589]

Without German patriotic revival, derivative and second-rank achievements would likely have been the summit of the German trajectory in the nineteenth century. German nationalism was strongly provoked by the Napoleonic disaster and its memory, and at intervals during the nineteenth century kept the German lands in a state of expectancy that some kind of a unified German nation built out of the various German polities would emerge. Democratization at mid-century proved abortive; however, modernization, including a bourgeois-motivated legal and administrative rationalization associated with the French Emperor, left an imprint on the German lands that could be drawn on to motivate learning—perhaps most striking in the sciences—as well as industry and military capability.

The fact that it was the Prussian king who "summoned all Germans to arms against the usurper Napoleon in March 1813", although far from bringing about an uncontested Prussian hegemony at that time in the German lands, prefigured the later Prussian leadership towards German unification.[590] After the combined European victory over Napoleon's forces at Leipzig in 1813 came an 1815 restoration of the European ruling houses. For a further fifty-five years after 1815, there was a continuation in the German lands of particularistic rule, albeit with some political consolidation. While the increasing rationalization during this period of the administration of the various German lands was helpful in bringing about a blossoming of

[589] Paul Volkmann, "Franz Neumann Als Experimentator," *Verhandlungen der deutschen physikalischen Gesellschaft* 12, no. 20 (1910): 786.
[590] Sagarra, *Germany in the Nineteenth Century: History and Literature*, 13.

education and research, including in science, it appears that the consolidation of a single Germany in 1871 was itself the occurrence most pivotal for the advancing preliminary developments in the *history* of science there. Unmistakably, the recounting of the long-standing if not unbroken German excellence in science served a national purpose for the new Germany.

THE POST-NAPOLEONIC DEVELOPMENTS

Ironically, the changes that had been introduced by Napoleon into those German regions in which he obtained dominion, with other German lands following on by example, formed the patterns followed during the subsequent decades in the post-Napoleonic period in advancing social, legal and economic modernization. Among the social changes bubbling through the French Revolution was an opening up of "scientific careers for the talented" to a broader range in the social spectrum.[591] During both the Revolutionary and Napoleonic periods, the French leadership set up institutions and created a climate conducive to science.[592] Napoleon I brought its practitioners to feel their national allegiance, and with the French scientific superiority continuing under his regime, he furthered the association between scientific prowess and national glory.[593] Although individual scientists had previously brought acclaim to their various native lands, the harnessing of collective scientific achievement for national purposes first took clear shape under Napoleon. The French Emperor, moreover, recognized certain achievements of foreign science. These measures of support and recognition by Napoleon served as a model for the German lands relatively soon after Napoleon's defeat. For all the rancor that his invasion of German territories aroused among most Germans, his stance on the behalf of science would be

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[591] Maurice Crosland, *Gay-Lussac: Scientist and Bourgeois* (Cambridge: Cambridge University Press, 1978), 16-17.
[592] Robert G. Gilpin, *France in the Age of the Scientific State* (Princeton: Princeton Univ. Press, 1968), 106.
[593] Kanz, *Nationalismus Und Internationale Zusammenarbeit in Den Naturwissenschaften: Die Deutsch-Französischen Wissenschaftsbeziehungen Zwischen Revolution Und Restauration, 1789-1832 Mit Einer Bibliographie Der Übersetzungen Naturwissenschaftlicher Werke*, 34. Maurice P. Crosland, *Science under Control: The French Academy of Sciences, 1795-1914* (Cambridge: Cambridge University Press, 2002), 23.

mirrored by the greater support given by the German states, and by the German Empire, for the scientific enterprise in the remainder of the nineteenth and early twentieth century.

The link made in this dissertation between the bourgeoisie and the German activity in the history of science mandates some consideration of that class and its defining characteristics. The scholar Tatiana Sfedu maintains that the German middle classes began from the late eighteenth century to impact all the domains of life.[594] Their adoption of a "scientific" approach reaching far beyond the practice of science itself was closely tied in with the evolution, in the words of Denise Phillips, of the eighteenth-century "Enlightenment public…into its much larger, more complex, and multilayered nineteenth century successor…"[595] As noted, Napoleon's intrusion, disregarding the immediate disarray, gave the German bourgeoisie a boost, for its lasting impact was the disengagement from many of the patterns associated with a way of life directed by the nobility.

Multiple German bourgeois classes, differing in "social composition, specific models for conduct, styles of life," co-existed, but during the nineteenth century from this variety a composite that exhibited certain quite widely shared traits was formed, shaped in the first instance by the bourgeois family, and second, by the educational institutions of German lands.[596] By the time the German word "*Bourgeoisie*" first took hold in 1840 ("*Bürgertum*" was a word which, already in some use in the late eighteenth and early nineteenth century as synonymous

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[594] Content taken from quotation from Alarich Rooch, Zwischen Museum und Warenhaus: Ästhetisierungsprozesse und sozialkommunikative Raumeignung des Bürgertums (1823-1920) (Oberhausen, Athena Verlag, 2001), 62 given in Sfedu, "Musemsgründung Und Bürgerliches Selbstverständnis: Die Familie Leiner Und Das Rosgartenmuseum in Konstanz", 24.

[595] Phillips, *Acolytes of Nature: Defining Natural Science in Germany, 1770-1850*, 3.

[596] Hans-Ulrich Wehler, "Wie Bürgerlich War Das Deutsche Kaiserreich?," in *Bürger Und Bürgerlichkeit Im 19. Jahrhundert*, ed. Jürgen Kocka (Göttingen: Vandenhoeck & Ruprecht, 1987), 252. Jonathan Sperber, "Bürger, Bürgertum, Bürgerlichkeit, Bürgerliche Gesellschaft: Studies of the German (Upper) Middle Class and Its Sociocultural World," *The Journal of Modern History* 69, no. 2 (1997): 275. Ayako Sakurai, *Science and Societies in Frankfurt Am Main* (New York: Routledge, 2016), 8.

with "*Mittelstand*" (middle estate)), the German middle classes were sharing some elements of a common ethos, and I will use the English term "bourgeoisie" to refer to them collectively.[597]

In the late eighteenth and early nineteenth centuries, the German bourgeoisie (especially its Protestant retinue) saw itself as being the principal bearer of culture, as giving access to culture to all Germans, and as making the principal contribution to the general good.[598] Liberals, largely drawn from the bourgeoisie, saw science as a template for the construction of social cooperation achieving progress grounded in reason and the cultural consolidation of the Germans.[599] As noted by David Blackbourn, the *Bildungsbürgertum* (educated bourgeoisie) entered the corps of state officials, while supplying the members of other groups that gained influence through professionalization, including doctors, engineers, architects and lawyers.[600] Increasingly, by the start of the middle third of the nineteenth century, the German scientists and technicians, a part of this complement of middle-class figures, stood to gain an increased professional stature by setting in place natural science as a lynchpin of a proto-national identity as this identity was being consolidated and readied for political expression. Members of the German local geographical societies, for example, according to Schelhaas and Honsch in their book on the history of the geographical profession, "developed into establishments" of the

[597] Jean-Baptiste Michel et al., "Quantitative Analysis of Culture Using Millions of Digitized Books (Google Books Ngram Viewer)," *Science* 331, no. 6014 (2011). Jürgen Kocka, "Bürgertum Und Bürgerlichkeit Als Probleme Der Deutschen Geschichte Vom Späten 18. Zum Frühen 20. Jahrhundert," in *Bürger Und Bürgerlichkeit Im 19. Jahrhundert*, ed. Jürgen Kocka (Göttingen: Vandenhoeck & Ruprecht, 1987), 24.
[598] Hermann Glaser, *Bildungsbürgertum Und Nationalismus: Politik Und Kultur Im Wilhelminischen Deutschland* (München: Deutscher Taschenbuch-Verlag, 1993), 227-28.
[599] Timothy Lenoir, "Laboratories, Medicine and Public Life " in *The Laboratory Revolution in Medicine* ed. Andrew Cunningham and Perry Williams (New York: Cambridge University Press, 1992), 33.
[600]Blackbourn, "The German Bourgeoisie: An Introduction," 4-6.

bourgeoisie, and these societies were headed towards an all-German organization when they met together in Frankfurt in 1865 even before the 1871 national unification.[601]

While Napoleon yet ravaged the German lands, Wilhelm von Humboldt's educational reforms, led by the foundation of the University of Berlin in 1811, had included a greater emphasis at *gymnasia* on mathematics, natural science, philosophy and German literature. The dispersion of this "German learning", with its elevation of the status of scholars, helped implant as well among future scientists as among future humanists a sense of a national identity (of a largely bourgeois type) through intellectual training.[602] The nineteenth century German historian Heinrich von Treitschke framed the first quarter of the nineteenth century as a period of the efflorescence of learning in general—and of German learning above all. The nineteenth century chemist and chemical biographer Jakob Volhard noted that in that quarter-century, in the areas of philology, history, jurisprudence, and philosophy, German achievement was particularly marked, while the sole domain of knowledge that the Germans showed themselves lagging in was the exact sciences. But this deficit was a cavernous one, according to a fellow chemist Justus Liebig, who came of age right at this time. Liebig faulted particularly physics and chemistry, in which the Germans, he said, had next to nothing to show.[603] However, the state of affairs began to markedly change in the second quarter of the century, in part because of Liebig's own educational initiative in providing university laboratory training in chemical research. The German lands, reintroducing a degree of scientific strength previously last seen a couple centuries earlier, with the progressing of the century became a byword for skill in science.

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[601] Bruno Schelhaas and Ingrid Honsch, "History of German Geography: Worldwide Reputation and Strategies of Nationalisation and Institutionalisation," in *Geography: Discipline, Profession and Subject since 1870 : An International Survey*, ed. Gary S. Dunbar (Dordrecht: Kluwer Academic Publishing, 2001), 12.
[602] Richard Olson, *Science and Scientism in Nineteenth-Century Europe* (Champaign: University of Illinois Press, 2008), 117, 21. Frank Lorenz Müller, *Our Fritz: Emperor Frederick Iii and the Political Culture of Imperial Germany* (Cambridge, MA: Harvard University Press, 2011), 10.
[603] Jacob Volhard, *Justus Von Liebig*, 2 vols., vol. 1 (Leipzig: Barth, 1909), 1.

In response to the revolutionary events in 1830 in France (the bourgeois July Revolution), Belgium, Russian Poland, to the riots in Italy and to the overturning of the oligarchy in parts of Switzerland,[604] administrations in the important second-tier German kingdoms of Saxony and Bavaria joined in the reactionary policies of Austria and Prussia.[605] This scenario may have very briefly slowed the development of science, but the impact was transient, for by the mid-1840s a significant political turmoil was pushing once again in the direction of liberalizing policies.

The bourgeoisie, inaugurating in this period a number of all-German organizations, were inclining towards a national German polity. Already in 1822, the annual meeting of the German Natural Scientists and Physicians had been founded, and along with this in 1837 the meeting of German Agriculturalists and Foresters; in 1838, the Association of German Philologists and Pedagogues took shape, while in 1846 a congress took place of all those involved in German studies including law (*Germanisten*).[606]

By the 1840s, German nationalists considered that a range of components together gave some coherence to their nation-to-be. The development of the post, the extension of newspaper activities, a dramatic upsurge in book production, the enhancements of roads, and the formation of a railway network were important in instilling the sense of a shared German enterprise.[607] The achievement of a feeling of commonality among the Germans was abetted by the vast increase in communications spearheaded by lending libraries—their use contributed to the first measure of national assimilation achieved on a widespread basis.[608] The operation of civic society was

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[604] Frederick Hertz and Frank Eyck, translated by Eric Northcott, *The Development of the German Public Mind: A Social History of German Political Sentiments, Aspirations and Ideas*, (London: Allen & Unwin, 1975), 135.
[605] Ibid., 143.
[606] Hans-Ulrich Wehler, "Der Nationalstaat Ensteht: Gegen Die Dynastien," *Spiegel Special : Geschichte* 1 (2007): 102.
[607] Helmut Walser Smith, "Nation and Nationalism," in *Germany 1800-1870*, ed. Jonathan Sperber (New York: Oxford University Press, 2004), 249.
[608] Sagarra, *Germany in the Nineteenth Century: History and Literature*, 139.

marked by a panoply of media sustaining the exchange of views.[609] There was an increased trade among German states and an increase in efficacy and speed of communications. A Customs Union (*Zollverein*), begun in the 1830s, in that decade and the next imposed higher protective levies on imports, and state banks were opened.[610] Although limited in its membership to begin with, the Customs Union, centered on Prussia, eventually pressured and successfully convinced most other German states of the wisdom of joining, while Prussia's manipulations managed to exclude Austria. Through the Customs Union, then, Prussia secured an additional standing in its bid to be the political leader of the German lands.[611] The build-up in the feeling of a common Germanness across state lines in turn increased the desire to accomplish new scientific deeds for the renown of German science.

A threat by the French in 1839 to again take the Rhine territory it had held under Napoleon galvanized especially the German bourgeoisie, displeased with the limited action their particularistic governments were prepared to take in the face of a foreign threat.[612] Attempts to suppress the nationalist movement proved to paradoxically have an energizing effect on the formation of political parties.[613] There was an enrichment of political discussion, while public opinion was more openly circulated, and an explicit political opposition gained a foothold. A stream of liberal-bourgeois energy ensued, opposing privileges associated with birth and in favor of increasing freedoms intellectually and economically. The prevailing "means tests" for political participation, once dominantly birth, were now personal financial standing and *Bildung*, or

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[609] James M. Brophy, "The Public Sphere," in *Germany 1800-1870*, ed. Jonathan Sperber (New York: Oxford University Press, 2004), 186.
[610] Hertz and Eyck, *The Development of the German Public Mind: A Social History of German Political Sentiments, Aspirations and Ideas*, 168.
[611] Sagarra, *Germany in the Nineteenth Century: History and Literature*, 37.
[612] David E. Barclay, "Political Trends and Movements, 1830-1850. The Vormärz and the Revolutions of 1848-1849," in *Germany 1800-1870*, ed. Jonathan Sperber (New York: Oxford University Press, 2004), 51.
[613] Hertz and Eyck, *The Development of the German Public Mind: A Social History of German Political Sentiments, Aspirations and Ideas*, 156.

personal development as primarily achieved through gymnasial and university training, travel, and intercourse with the educated elite. To move up the social scale into the upper-middle class, the two essential assets needed were now upbringing and *Bildung*.[614] By the late 1840s, the primacy of profession and work, the bourgeois standards, was in place. The old allegiances to dynasty, local territory, and religion were in the process of being eroded in the successive decades of the nineteenth century.

THE ATTEMPT AT A POLITICAL TRANSFORMATION IN 1848-1849

The most significant year of the 1840s was 1848. The trend of an increasing mobilization of political energies, especially of the bourgeoisie, and of a challenge to the existing order, led to a temporary upending of German political life on a nearly nationwide basis.[615] Political nationalism got a hold—though firmly opposed by a gauntlet of the German rulers. A national assembly, the idea for which had support from both moderates and radicals, was convoked in Frankfurt—including representatives from Austria—with the intention that representative government and German political unity be permanently secured. Its Constitutional Committee brought forward a recommendation that all the Germans be accorded national citizenship as a part of a draft constitution.[616] The radicals (in the terminology of the time) were mostly in favor of republicanism, while the moderates were generally of the view that the monarchical principle should be maintained at the all-German level because it was, they maintained, historically the case that national unity proceeded from strong kings.[617] Whether the leadership should devolve

[614] Rudolf Vierhaus, "Der Aufstieg Des Bürgertums Vom Späten 18. Jahrhundert Bis 1848/49," in *Bürger Und Bürgerlichkeit Im 19. Jahrhundert*, ed. Jürgen Kocka (Göttingen: Vandenhoeck & Ruprecht, 1987), 75.
[615] Sagarra, *Germany in the Nineteenth Century: History and Literature*, 28.
[616] Blackbourn, *The Long Nineteenth Century: A History of Germany, 1780-1918*, 148, 64.
[617] Hertz and Eyck, *The Development of the German Public Mind: A Social History of German Political Sentiments, Aspirations and Ideas*, 135.

on Prussia or Austria, or some form of a rotating directorate, was contested. The German scientists were not of one mind about the political future. Rudolph Virchow, as a participant in the liberal/democratic revolution of 1848, was probably the practitioner and exponent of science most forcibly in favor of republicanism.

Concurrently with the national assembly, individual assemblies of the states of the German Confederation met which abraded the perceived legitimacy of the national assembly. After a year and more of hopes and plans, the national assembly was marginalized and eventually militarily forced to disband, dashing the hopes for an immediate German unification and the installation of a representative government at the national level. But science continued to prosper in the various German states, whose leaderships saw the importance of supporting it for intellectual recognition if not yet for prosperity. The later tight bonds between the economy, technology, and political ambition were also already assembling.[618]

Attachments in the eighteenth century once directed to the Holy Roman Empire became reconfigured as one lesser strain of nineteenth-century German nationalism.[619] German nationalism over time during the nineteenth century shifted increasingly towards an exclusive German cast. In the 1830s Germans had associated their own national movement as one manifestation among others of a spirit affecting various European peoples in pursuit of emancipation. Subsequently, however, the tension between the German aims and the aspiration of the adjacent peoples, most notably the Poles, led increasingly to a German nationalism, broadly held among ethnic Germans, that accorded much the greatest significance to their own

[618] Sagarra, *Germany in the Nineteenth Century: History and Literature*, 110. Bruno Seidel, "Die Wirtschaftsgesinnung Des Wilhelminischen Zeitalters," in *Zeitgeist Im Wandel: Das Wilhelminische Zeitalter*, ed. Hans Joachim Schoeps (Stuttgart: E. Klett, 1967), 181.
[619] Sperber, "Introduction," 18.

emancipation.[620] Karl Hillebrand wrote in 1874 that already in the forties, the German learning was adopting a posture of superiority and arrogance, sometimes starting to denigrate Romance and Slavic peoples.[621]

The German history of the nineteenth century must incorporate industrialization as a key societal development. The initiation of the process occurred during the second two-thirds of the century. The prominent historian James Sheehan cites the economic growth in the middle decades of the century as of a paramount importance in nineteenth-century German history.[622] Abigail Green summarizes that historians generally position the time of the take-off of the German economy to sometime between the middle of the 1840s to the start of the 1850s. 1850-1873 was a first boom period.[623] By 1850, all the German states saw that industrialization was producing revenue for governments and contributed to the development of armaments, which were occurrences favorable for state investment in university scientific institutes whose activities were presumed to be favorable to technology.[624] There was a transition, sometime in the middle decades of the nineteenth century, from a German industrial tutelage, depending on machinery of British manufacture, to an era in which the German lands built the machines they would utilize. Starting from a position of thorough-going industrial underdevelopment in the early decades of the century, extending at the least up to 1830, still, after about two decades of industrial development, by 1866 the German lands' economy's turn to industry had remained principally

[620] Sagarra, *Germany in the Nineteenth Century: History and Literature*, 98.
[621] Hertz and Eyck, *The Development of the German Public Mind: A Social History of German Political Sentiments, Aspirations and Ideas*, 335.
[622] Sheehan, *German History, 1770-1866*, 731.
[623] Abigail Green, "Political and Diplomatic Movements, 1850-1870: National Movement, Liberal Movement, Great-Power Struggles, and the Creation of the German Empire," in *Germany 1800-1870*, ed. Jonathan Sperber (New York: Oxford University Press, 2004), 73.
[624] Brose, *German History 1789-1871: From the Holy Roman Empire to the Bismarckian Reich*, 284.

confined to heavy industry.[625] That is, while it is meaningful to speak of a German industrial development during the second third of the century, its penetration to the sectors other than heavy industry was more associated with the period of the German Empire.

A significant part of the German professoriate was prone, after the failure of democracy in the German lands in 1848, to retreat into careerism and the attempt to rise higher in the social scale; it exhibited increasing militaristic and chauvinistic tendencies and a disdain for democratic process and parliamentarism.[626] And for those of the professoriate who had participated in the freedom movement of 1848, once it had been suppressed, the tendency among them was to shift their aspirations towards the advancement of science. Following the suppression of the German 1848 revolution, a gamut of responses by the intellectual elite occurred, some of them favorable to raising an awareness of science. It was no longer possible to directly advocate for change of the ruling order, yet advocating for science was a means of intruding on the authority of state and church.[627] Perhaps it was in order to challenge the latter that the production soon after 1848, as charted by Nicolaas Rupke, of a number of biographies of the quintessential early nineteenth century scientific figure Alexander von Humboldt took place.[628]

The idea of a "little" German nation under Prussian leadership gained favor. In the 1850s, Prussia was somewhat more amenable to representative institutions than Austria. In 1859 Austria, after declaring war on the French, lost further esteem among the German states by signing an armistice with the French and a new Kingdom of Italy that gave the French the territories of Nice and Savoy, instead of Austria's pursuing the war that it had declared. A wide-

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[625] Brendan Simms, "Political and Diplomatic Movements, 1800-1830," in *Germany 1800-1870*, ed. Jonathan Sperber (New York: Oxford University Press, 2004), 40. Sperber, "Introduction."
[626] Glaser, *Bildungsbürgertum Und Nationalismus: Politik Und Kultur Im Wilhelminischen Deutschland*, 133.
[627] Alfred Kelly, *The Descent of Darwin: The Popularization of Darwinism in Germany, 1860-1914* (Chapel Hill: University of North Carolina Press, 1981), 143.
[628] Nicolaas A. Rupke, *Alexander Von Humboldt: A Metabiography* (Chicago, Ill.: University of Chicago Press, 2008), 29-54. Humboldt also has a claim to have been doing history of science from early in the nineteenth century -- see C. A. Browne, "Alexander Von Humboldt as Historian of Science in Latin America," *Isis* 35, no. 2 (1944).

ranging German nationalism ensued in the aftermath of this French expansion, a development that also was conducive to the promotion of the combined German scientific enterprise vis-à-vis competitor nations.

The upbeat commercial environment increased the acceptance for the time being of the particularistic German regimes that had survived the freedom movement of 1848-1849. This was despite the fact that they had taken a step backward in representativeness.[629] However, *national associations*, primarily bourgeois in orientation, as was associational life in the German lands generally, became more prevalent in the 1850s and 1860s. The trend of formation of inclusive German organizations that had taken place in the 1820s, 1830s, and 1840s picked up pace in the 1850s. "National" organizations inclusive of various German lands tended *de facto* towards greater political unity. Among these was the German Chamber of Commerce, drawing its membership from all German lands except those of Austria.[630] Also in the 1860s, the General Association of German Women formed, giving its support to the national project.[631] Such organizations were mechanisms that worked in favor of strengthening the sense of a national identity among the portion of the population considered native German, if they did not solve the problem of the existence of a number of groups deemed outsiders within the German lands.

In the territory of what would become Germany, after the 1860s one could discern that the taste, fashion, and norms of polite society, the spirit in which local government was conducted, the dominant sense of law and morality and those of private property and social obligation were shaped by the bourgeoisie.[632] Bourgeois and liberal values were to some extent

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[629] Sagarra, *Germany in the Nineteenth Century: History and Literature*, 115-16.
[630] Smith, "Nation and Nationalism," 253. Sperber, "Introduction," 22.
[631] Eve Rosenhaft, "Gender," in *Germany 1800-1870*, ed. Jonathan Sperber (New York: Oxford University Press, 2004), 228-29.
[632] Geoff Eley, "Liberalism, Europe, and the Bourgeoisie," in *The German Bourgeoisie: Essays on the Social History of the German Middle Class from the Late Eighteenth to the Early Twentieth Century*, ed. David Blackbourn and Richard Evans (London: Routledge, 1991), 297.

interchangeable: an emphasis on progress, education, achievement, and work, the support for culture, science and continuing advances, the ascription of the fundamental importance of moral fiber and autonomy, derived from sufficient financial means, the store of resources necessary to plan ahead, and a designated minimum of education.[633]

Already before mid-nineteenth century, the German middle classes were optimistic that collectively they were destined to a societal and political precedence in the modern world.[634] Historian Lynn Nyhart's claim that "the job of the [nineteenth century] public museum was to educate their [the masses'] sensibilities toward a more middle-class valuation of the truth, and an appreciation of science as a source of that truth" reinforces this dissertation's emphasis on the German bourgeoisie's essential role in giving shape to the early discipline of the history of science, as part of its Empire program of self-affirmation in at least the cultural realm.[635] For Thomas Broman, the bourgeoisie's pretension to scientific know-how lent force to its claim to represent all of society, for science operated as the most accessible and public of knowledge types.[636] The turn to science took shape in step with an increasing secularization of culture.[637] The bourgeoisie made out that it engendered social and technical progress and embodied

[633]Blackbourn, "The German Bourgeoisie: An Introduction," 19. Christoph Meinel, *Karl Friedrich Zöllner Und Die Wissenschaftskultur Der Gründerzeit: Eine Fallstudie Zur Genese Konservativer Zivilisationskritik* (Berlin: ERS-Verlag, 1991), 9.
[634] Brose, *German History 1789-1871: From the Holy Roman Empire to the Bismarckian Reich*, 188.
[635] Lynn K. Nyhart, "Science, Art, and Authenticity in Natural History Displays," in *Models: The Third Dimension of Science*, ed. Soraya de Chadarevian and Nick Hopwood (Stanford: Stanford University Press, 2004), 330.
[636]Thomas Broman, "Introduction: Some Preliminary Considerations on Science and Civil Society," *Osiris* 17 (2002): 14.
[637] Sheehan, *German History, 1770-1866*, 816. Cecilia Applegate, "Localism and the German Bourgeoisie: The 'Heimat' Movement in the Rhenish Palatinate before 1914," in *The German Bourgeoisie: Essays on the Social History of the German Middle Class from the Late Eighteenth to the Early Twentieth Century*, ed. David Blackbourn and Richard Evans (London: Routledge, 1991), 244. Edgar Feuchtwanger, *Imperial Germany, 1850-1918* (London: Routledge, 2001), 5 notes that this attitude especially characterized the educated elite rather than the economic elite.

rationality.[638] Along with formation of the nation-state, the heightened role of the bourgeoisie was essential to nineteenth century modernization.

BISMARCK AND GERMAN UNIFICATION

When Otto von Bismarck was recalled from diplomatic service to serve in the early 1860s as the Minister-President of Prussia and later as Chancellor of the German Empire, the pace of political events again picked up. Bismarck, using guile and decisiveness to overcome resistance to a Prussian-led Germany, directed foreign affairs in such a way as to ward off disapproval of his high-handed *domestic* actions. He was able to engender German patriotism under Prussian leadership at war with Denmark in 1864. He then succeeded in goading Austria into declaring war on Prussia in 1866 and defeated the Hapsburgs, thereby excluding them from further consideration as the leader of a future Germany while extending the territory held by Prussia. He formed a North German Confederation which Prussia dominated, while a number of south German states remained apart. Finally he lured France into declaring war on Prussia in 1870, whereupon most parts of the German lands except Austria joined together against France, which was badly defeated. The King of Prussia was installed as the Emperor of a finally unified Germany, now termed an Empire.

A substantial amount of publicist activity accompanied the political developments in the period leading up to 1871 unification. This helped to ensure that when unification was accomplished, the German scientific enterprise would be highly self-conscious about its contribution to national might, prosperity and identity. Helmut Walser Smith provides a vivid portrait:

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[638] Sheehan, *German History, 1770-1866*, 523. Meinel, *Karl Friedrich Zöllner Und Die Wissenschaftskultur Der Gründerzeit: Eine Fallstudie Zur Genese Konservativer Zivilisationskritik*, 9.

> [n]ationalism spilled over from politics into other semantic fields…'Ethnoscapes' now coloured the hills; meadows were no longer green but German; rivers, especially the Rhine, were declared national sanctuaries; oak trees [became]…metaphors of [German] steadfast loyalty…The woods themselves took on a sacral aura as a site of a special kind of…Germanic freedom.[639]

He geologist Julius Fröbel wrote of the tendency the Germans had to append the term "German" to all manner of things.[640] Correspondingly, in German scientific popularization, the results of research in physics, geology or chemistry were put forward as German, just as indigenous animals and plants were.[641]

As a new nation, Germany forged ahead economically and technologically. There was a considerable contribution by the findings of science to the early onset of the industrial enterprise in Germany. In turn, industrialization directly led to harnessing of science through the formation of industrial laboratories beginning in the chemical industry in the 1880s.[642] Despite its gains from economic modernization, however, the character of the unified German state that came with a rush in 1871 has been considered inadequately politically modern (overly autocratic, with undue political influence of nobles, the great landed proprietors, the officer corps, and the higher bureaucracy)[643] and not adjusted to key components of industrializing society.[644]

After 1871, there was some lack of clarity in the way the responsibilities were divided between local, state and Reich government.[645] In certain respects the new arrangement tolerated

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[639] Smith, "Nation and Nationalism," 241-42.
[640] Julius Fröbel, "Der Deutsche Geist Vor Dem Spiegel," in *Bildungsbürgertum Und Nationalismus: Politik Und Kultur Im Wilhelminischen Deutschland*, ed. Hermann Glaser (Munich: Deutscher Taschenbuch-Verlag, 1993 (original in 1866)), 231.
[641] Angela Schwarz, *Der Schlüssel Zur Modernen Welt: Wissenschaftspopularisierung in Grossbritannien Und Deutschland Im Übergang Zur Moderne (Ca. 1870-1914)* (Stuttgart: F. Steiner, 1999), 161.
[642] George Meyer-Thurow, "The Industrialization of Invention: A Case Study from the German Chemical Industry," *Isis* 73, no. 3 (1982): 364.
[643] Jürgen Kocka, "Einleitung," in *Bürger Und Bürgerlichkeit Im 19. Jahrhundert*, ed. Jürgen Kocka (Göttingen: Vandenhoeck & Ruprecht, 1987), 11.
[644] Mark Hewitson, "*Nation* and *Nationalismus*: Representation and National Identity in Imperial Germany," in *Representing the German Nation: History and Identity in Twentieth-Century Germany*, ed. Mary Fulbrook and Martin Swales (Manchester: Manchester University Press, 2000), 21-22.
[645] Ibid., 45.

a good amount of independence of constituent units (*Länder*). But *de facto*, formerly Prussian norms were widely extended to the rest of the German Empire. Yet there had previously been a considerable opposition in parts of Germany to the idea of formation of the nation centered on Prussia. Thus, although German lands had progressed to becoming a nation in 1871, there were a number of competing allegiances and identities for its citizens, among them the regional identities that had been imprinted, in some cases, during feudal days.[646]

A continuing effort after unification to further bring Germans together was essential. One problematic aspect was that whole bodies of people were treated as outsiders, including Poles, Danes, Alsatians, Catholics, Jews, and socialists.[647] Significant numbers of the middle class during the Empire were drawn into an increasingly aggressive nationalistic posture which, superseding an earlier "liberal-emancipatory nationalism", played an integrating function for the core German population while *Reichsfeinde* (enemies) were defined internally as well as externally.[648] There were other excluded groups, including the uneducated, the pauperized, and certain other less populous ethnic groups. Residential divisions by class, intentionally sought by the bourgeoisie, became characteristic of the years from 1850-1875, promoting the spatial separation of the prototypical (bourgeois) German.[649] The tendency also arose to make little distinction between outsiders and enemies. The result was a majority pride in, and arrogance about, Germany for Protestant non-socialist Germans. By the 1880s a strident nationalism was urged in some quarters, replete with "chauvinist bile",[650] serving in its own way to advance the sense of a common German identity among those who fit the prescription for belonging.

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[646] Wehler, "Der Nationalstaat Ensteht: Gegen Die Dynastien," 105.
[647] Sagarra, *Germany in the Nineteenth Century: History and Literature*, 110-11.
[648] Wehler, "Wie Bürgerlich War Das Deutsche Kaiserreich?," 253.
[649] Blackbourn, *The Long Nineteenth Century: A History of Germany, 1780-1918*, 207.
[650] Ibid., 426.

Even after the formation of a unified polity, the forging of a common currency and the introduction of a common legal code, Germany had much to overcome before it was unified more broadly. Harold James has referred to Imperial Germany as being suffused "with all the unfulfilled ambitions and romantic expectations of a movement for national awakening."[651] This dissertation has underlined that with persisting divisions among the German people, there was a chance for German science and its past to serve as a unifying element.

The German historian Hans-Ulrich Wehler and his British colleague David Blackbourn have debated how far the German Empire can be designated a "bourgeois society". They agree that the newly unified state offered advantages to *both* nobility and bourgeoisie. By 1879 Bismarck had managed to lessen the momentum of the liberal faction in the Prussian and imperial diets, even though liberal opinion could savor certain guarantees introduced after 1866 or 1871 to the North German Confederation and then to the German Empire: the rule of law, and a favorable set of legislation regarding commerce covering company, banking, and currency, and patent protection.[652]

Wehler speaks of a bourgeois flight into culture and a corresponding acceptance of blunted political influence by the bourgeoisie, while he acknowledges at the same time that all points of view had pretty much unfettered expression during the Empire. If the modernization of Germany was a partial one, Imperial society allowed some marks of liberalization, the expression of political differences, and the introduction of enhancements to civic principles.[653] And if the liberal middle class did not command Imperial politics, the imprint of the bourgeoisie on society was profound. Paul Weindling writes, further, that advancing medical science

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[651] Harold James, A German Identity, 1770-1990 (London: Weidenfeld & Nicolson, 1989), 33, quoted in footnote 4, Hewitson, "*Nation* and *Nationalismus*: Representation and National Identity in Imperial Germany," 21.
[652] Blackbourn, *The Long Nineteenth Century: A History of Germany, 1780-1918*, 258. Feuchtwanger, *Imperial Germany, 1850-1918*, 49.
[653] Wehler, "Wie Bürgerlich War Das Deutsche Kaiserreich?," 266.

substantiated medical authority, and this authority then advanced a diverse group of bourgeois positions, among them patriotism and nationalism.[654]

Museums open to the general population became one aspect of a bourgeois-inscribed social order now commanding sufficient leisure to make use of them. One acute appraisal remarks that

> the beginnings of the institution of museum are tightly enlaced with the process of self-discovery of the bourgeoisie in the nineteenth century. To this extent, the investigation of a museum's history is also a contribution to scholarship on the bourgeoisie…The publicly accessible, non-profit museum is to be recognized…as the product and cultural instrument of bourgeois society.[655]

Another similar comment goes:

> The modern museum made its appearance with the arrival of bourgeois society...The museums of bourgeois society are characterized by their being open to a large public and by their pedagogical aim, as opposed to the collections of the *Ancien Régime* [the old European monarchical order that was in place before the French Revolution] that were reserved to an elite.[656]

The founding of museums, in their role as educators of the public, has been termed a mechanism of dominance by the bourgeoisie, introducing middle-class standards for culture and an orientation to natural scientific understanding to the broader society.[657] Beginning in the mid-nineteenth century if not earlier, this influence of the bourgeoisie through the medium of museums was extended with the rise of what has been termed "exhibition culture," whose temporary displays initially were expressions of burgeoning technology (the onset of the

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[654] Paul Weindling, "Bourgeois Values, Doctors and the State: The Professionalization of Medicine in Germany 1848-1933," in *The German Bourgeoisie: Essays on the Social History of the German Middle Class from the Late Eighteenth to the Early Twentieth Century*, ed. David Blackbourn and Richard Evans (London: Routledge, 1991), 218.

[655] Sfedu, "Musemsgründung Und Bürgerliches Selbstverständnis: Die Familie Leiner Und Das Rosgartenmuseum in Konstanz", 8.

[656] Eckard Bolenz, "Entre Publicité, Nostalgie Et Pédgagoie: L'evolution Des Musées Des Techniques Et De L'industrie En Allemagne," in *La Société Industrielle Et Ses Musées: Demande Sociale Et Choix Politiques 1890-1990*, ed. Brigitte Schroeder-Gudehus, Eckhard Bolenz, and Anne Rasmussen (Montreux: Gordon et Branch, 1992), 240.

[657] Samuel J. M. M. Alberti, *Nature and Culture: Objects, Disciplines and the Manchester Museum* (Manchester: Manchester University Press, 2009), 24.

industrial economy, including advancing methods of transport and communication) that were then extended to incorporate purportedly universal educational ("the lessons of things") and recreational interests (the entertainment of things).[658] The temporary displays and permanent exhibitions covered in the dissertation were part of the bourgeois cult of exhibition.

The press commentary in Germany near the end of the nineteenth century underlined that work (a central bourgeois preoccupation) was central to its society in a measure that was unmatched elsewhere—and that its scientists exhibited this characteristic work ethic.[659] The *Gartenlaube*, a singularly successful family-oriented journal with a readership in perhaps the millions by 1875, making it the first German publication to reach these levels, set forth the case with respect to German emigrants; they were characterized, it argued, by strength, resolve, technical ability, work-orientation and persistence.[660] Walther von Dyck, in writing of the German instrument-makers Georg von Reichenbach and Joseph von Fraunhofer, maintained that they "proved again the old fame of German work…"[661] In 1887, astronomer Wilhelm Foerster, in a speech on Fraunhofer, ascribed to the Germanic race a talent for precision technology.[662] In the same year, Gustav von Gossler, head of the Prussian Ministry of Culture, viewed the maintenance of a government-funded precision technology testing and research laboratory as "emblematic of a 'German national character.'"[663] At the 1893 Chicago World's Fair, Otto Witt in the introduction to the catalogue for the German exhibition wrote of "…the main-spring and

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[658] Robert Brain, *Going to the Fair: Readings in the Culture of Nineteenth-Century Exhibitions* (Cambridge, U. K.: Whipple Museum of the History of Science, 1993), 9, 15. Jim Bennett, "European Science Museums and the Museum Boerhaave," in *75 Jaar Museum Boerhaave*, ed. Willem Otterspeer (Leiden: Museum Boerhaave, 2006), 76.
[659] Michael Conrad, translated by Sorcha O'Hagan *Globalisation and the Nation in Imperial Germany* (New York: Cambridge University Press, 2010), 336.
[660] Kirsten Belgum, "A Nation for the Masses: Production of German Identity in the Late-Nineteenth-Century Popular Press," in *A User's Guide to German Cultural Studies.*, ed. Scott D. Denham, Irene Kacandes, and Jonathan Petropoulos (Ann Arbor: University of Michigan Press, 1997), 174.
[661] Dyck, *Georg Von Reichenbach: Lebensbeschreibungen Und Urkunden*, 22.
[662] Myles Jackson, *Spectrum of Belief: Joseph Von Fraunhofer and the Craft of Precision Mechanics* (Cambridge, MA: MIT Press, 2000), 185.
[663] Ibid., 203

the guiding thread of all public and private life in the German Empire [which is]…a struggle for ever higher achievement by honorable, hard and incessant work."[664]

During the 1870s and 1880s, in seeming disregard of the indispensability of drawing the nation together, Bismarck launched two campaigns that put the unity of Germany in doubt. One, against Catholics in the so-called *Kulturkampf* (cultural war) was initiated as early as 1871 and was curbed only at the end of the decade of the 'seventies, though it was not completely dissipated until late in the 'eighties. Meanwhile, important as Germany advanced industrially was the formation of a social democratic constituency whose first allegiance was to its political party. Bismarck went on the offensive against the social democrats in 1878, with a discussion of anti-socialist legislation in the Reichstag, the German diet. Both Catholics and Social Democrats, in their time, were dubbed *Reichsfeinde* (enemies of the state) during these campaigns. But at various times, Bismarck was also at odds with the Center Party, the Progressive Party, the Liberal Party, even at times with the Conservative Party, and also with the German Poles; Bismarck proceeded in his policies largely by confrontation, but this predisposed the new nation to deep splits. Also, there was a consequential split between the middle class by virtue of wealth (*Besitzbürgertum*) and that by virtue of education and position (*Bildungsbürgertum*), the latter formed through an alliance of the professional and administrative classes.[665]

If divisions remained, after unification many Germans could not repress a pride in the new political order, even if they might have previously questioned the political wisdom and ethics of Bismarck.[666] Among the reasons that chauvinism took root in the new Germany were

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[664] Witt, "Einleitung," ii [no actual pagination].
[665] Blackbourn, *The Long Nineteenth Century: A History of Germany, 1780-1918*, 211. Fritz K. Ringer, *The Decline of the German Mandarins: The German Academic Community, 1890-1933* (Hanover, NH: University Press of New England, 1990), 34.
[666] Hertz and Eyck, *The Development of the German Public Mind: A Social History of German Political Sentiments, Aspirations and Ideas*, 332. Müller, *Our Fritz: Emperor Frederick Iii and the Political Culture of Imperial Germany*, 8.

the great military victory over France, the sudden attainment of a unified nation, and the feeling of the Germans that they were culturally elevated and distinct.[667] Protestantism underwent a remaking in the last several decades of the nineteenth century to emerge as a position of "vague cultural nationalism", according to Erik Linstrum.[668]

Once unification under Prussian leadership had been achieved, it became essential to give the new community of German citizens a sense of its roots. The German Empire involvement with the history of science owed no small debt to the part it could play in helping elevate its citizens' sense of the German scientific past to a position concordant with hopes for the new nation's efflorescence. The bourgeoisie, strongly implicated in the German nation's increase in activity in the history of science, hoped that unification would bring it enhanced stature and influence. While this did not proceed as hoped for in every respect, there was indisputably a gradual consolidation of the sense of a national identity, importantly linked with science.

Nonetheless, contemporary German claims for the onset of unanimous approbation of the new order represented by a unified Germany were certainly overdrawn.[669] Although as Mark Hewitson confirms, nineteenth century German historian Heinrich von Treitschke's view was that the majority of Germans rapidly fell in with the legitimacy of the new state, there was more likely a process of *gradual* accommodation; the second decade of the state's existence brought more widespread acceptance than the first.[670] It needed some time and the generation of some

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[667] Fritz Richard Stern, *Gold and Iron: Bismarck, Bleichröder, and the Building of the German Empire* (New York: Knopf, 1977), 159-61; Blackbourn, *The Long Nineteenth Century: A History of Germany, 1780-1918*, 427. Hewitson, "*Nation* and *Nationalismus*: Representation and National Identity in Imperial Germany."

[668] Erik Linstrum, "Strauss's Life of Jesus: Publication and the Politics of the German Public Sphere," *Journal of the History of Ideas* 71, no. 4 (2010): 615.

[669] Hertz and Eyck, *The Development of the German Public Mind: A Social History of German Political Sentiments, Aspirations and Ideas*, 347.

[670] Hewitson, "*Nation* and *Nationalismus*: Representation and National Identity in Imperial Germany," 46-47. Kirsten Belgum, *Popularizing the Nation: Audience, Representation, and the Production of Identity in Die Gartenlaube, 1853-1900* (Lincoln, NE: University of Nebraska Press, 1998), 56.

institutions in order to be seen to have acquired permanency.[671] The set of proto-national and national institutions which had previously been or were newly created started to take hold in people's minds as the frame of the new social order.[672] Overall, the condensation of a national German identity from people of widely differing backgrounds was promoted in the wake of political unification through the agency of primary schools, *gymnasia*, and universities as they taught a version of German history that made the new order seem inevitable, of the military with its brand of instruction, and of the large ex-military organizations (*Kriegervereine*). A further impetus to the coalescing of a German national identity was the highly competitive stance maintained by nations neighboring to Germany.[673]

AFTER BISMARCK, AS WILHELM II TAKES THE REINS

The dismissal of Bismarck from his political offices in 1890 relatively soon after the accession of Emperor Wilhelm II was a harbinger of an even more fractious Germany, likely coinciding with a heightened national sense of threatened security. As Hermann Glaser characterizes the times,

> [t]he national consciousness coarsened and narrowed, and soon coincided with the idea of the imperial world power [*Machtstaat*]. A positivistic understanding of history and the shift to German world power- and colonial-politics joined with a growing cultural pessimism, an exposure of the irrational nature of history and the disparagement of progressive possibilities of development.[674]

At the same time, there was a greater appeal to integral nationalism, marginalizing those not deemed racially German. These views were shared by the teaching force, and promoted by a

[671] Blackbourn, *The Long Nineteenth Century: A History of Germany, 1780-1918*, 259.
[672] Ibid., 265.
[673] Wehler, "Der Nationalstaat Ensteht: Gegen Die Dynastien," 105-06.
[674] Glaser, *Bildungsbürgertum Und Nationalismus: Politik Und Kultur Im Wilhelminischen Deutschland*, 113.

number of the political parties.[675] Headed by Wilhelm II, the German leadership, meanwhile, wished to make a showing on the international stage come what might.[676]

During all but the early years of the reign of Wilhelm I as Emperor and again during the start of the reign of Wilhelm II, in which economic gains seemed less certain, a more strident nationalism advanced, which glorified the nation and sought to insist on Germany's mandate to pursue *Weltpolitik,* a politics consequential for the whole world. Colonialist and Pan-Germanist Fritz Bley in 1897 in a work titled *Die Weltstellung des Deutschtums* (*The World Rank of Germanhood*) put the case for German superiority baldly: "We are the most accomplished people in all areas of knowledge and of the fine arts."[677] In 1911, celebrating the fortieth anniversary of the founding of the Empire, an organization of nationalists issued a catalogue, significantly titled *Deutschland als Weltmacht* (*Germany as World Power*) which straightaway proclaimed that

> in the Wars of Liberation [against Napoleon] the German people gave to an astonished world the proof of its strength, its capacity, its will. It…in 1870 joined, in the awareness of its strength that compelled consideration, the set of the world-ranking [*weltgeltenden*] peoples…Germany entered onto a victory run [*Siegeslauf*] in the history of peoples that is doubtless unique.[678]

The environment promoted national scientific rivalry and, directly relevant to this dissertation, the showcasing of long-standing German achievement in the sciences. The population as a whole took a patriotic pride in Germany's movement to becoming a mighty nation.[679] By the days of the German Empire, Germanhood [*Deutschtum*] stood for the qualities that had supposedly evened up across the board, and possibly reversed, the foregoing dominance,

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[675] Blackbourn, *The Long Nineteenth Century: A History of Germany, 1780-1918*, 440.
[676] Ibid., 450.
[677] Citation in Glaser, *Bildungsbürgertum Und Nationalismus: Politik Und Kultur Im Wilhelminischen Deutschland*, 183.
[678] Kaiser-Wilhelm-Dank and Verein-der-Soldatenfreunde, *Deutschland Als Weltmacht: Vierzig Jahre Deutsches Reich, Unter Mitarbeit Einer Grossen Anzahl Berufener Deutscher Gelehrter, Offiziere Und Fachmänner*, iii.
[679] J. Alden Nichols, *The Year of the Three Kaisers: Bismarck and the German Succession, 1887-88* (Urbana: University of Illinois Press, 1987), 139.

including in science, of the French or the British.[680] Majority German national traits were conspicuously, favorably, and repeatedly commented on by the German publicists, and a large sector of the young and middle-aged Germans had celebrated the nation through rituals of one kind or another by the first decade of the twentieth century.[681] A rhetoric of superiority proclaimed the national worth. For the German publicists, it was important to treat German identity as self-assured, masking the multiple divisions that held the Germans apart despite their union in an Empire. Still, there had been people in the soon-to-be, and now in the new, nation, including some scientists, who entertained doubts, if masked by an air of stridency, on how its culture measured up to that of other nations.[682] There was also fear among some Germans, shared by some polemicists in other nations as well, of the creep of degeneration [*Entartung*] and decadence (either home-grown or spreading from France.)[683]

It was not surprising that, in an attempt to draw out the Germans' sense of commonality, some commentators emphasized that the nation had external opponents and obstructers. Rudolf Virchow, conjuring external threat, already demonstrated in 1865 the use of fear in pulling Germans together : "We've experienced repeatedly how the spirit of German research has been attacked from within and without."[684] In 1883, giving a view of lingering tensions between French and German businessmen, Emil Busch, the commercial advisor of an optics manufacturer, wrote that no nation was as partial as the French, who would frown at any

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[680]Hewitson, "*Nation* and *Nationalismus*: Representation and National Identity in Imperial Germany," 21.
[681] Ibid., 28-32.
[682] Robin Lenman, "From "Brown Sauce" To "Plein Air": Taste and the Art Market in Germany 1889-1910," in *Imagining Modern German Culture, 1889-1910*, ed. Françoise Forster-Hahn (Washington: National Gallery of Art, 1996), 55.
[683] Theodor Birt, *Deutsche Wissenschaft Im 19. Jahrhundert: Eine Rede Zur Jahrhundertwende, Gehalten Am 9. Januar 1900* (Marburg: Elwert, 1900), 7. Max Nordau, *Entartung* (Berlin: Duncker, 1892).
[684] Rudolf Virchow, *Ueber Die Nationale Entwickelung Und Bedeutung Der Naturwissenschaften: Rede Gehalten in Der Zweiten Allgemeinen Sitzung Der Versammlung Deutscher Naturforscher Und Aerzte Zu Hannover Am 20. September 1865* (Berlin: A. Hirschwald, 1865), 26.

German-manufactured product.[685] In 1900 the editor of the *Zeitschrift für mathematische und naturwissenschaftliche Unterricht* (*Journal for Mathematical and Natural Scientific Education*) wrote,

> [f]or…through the advances of the natural sciences generally and specifically of technology, the all-too-large dominance of theory is upended, and applications, previously disdainfully neglected by theory, now claim its [that is, theory's] rights. And this must take place, for our people not to be destroyed in the competition of nations.[686]

In a memoir written in 1909 seeking to convince the Emperor that a series of ancillary scientific institutes should be mounted in Germany, the head of the Royal Library Adolf von Harnack emphasized that it was now commonly perceived that the nation's leadership in scientific research had been ceded to foreign lands in "most important parts."[687]

> [T]oday, with its extraordinarily heightened feelings of nationalism, a national stamp is imprinted on each scientific research finding…People read today in scientific publications of German, French and American research results and researchers, which was not the case earlier in such degree. Peoples attend to designating with each new scientific advance the nationality of the person or people making it. They are supported by the press in a never-previously practiced manner, in a carefully evaluated way.[688]

Like not a few others, physicist Ernst Gerland was not fully serene about Germany's position. In 1910 he wrote, "[w]ith culture, also envy has increased...To the enemies, which surrounding our Fatherland threaten us from without, there are joined great inner dangers."[689]

Rudy Koshar adopts the telling phrase that German Empire "national monuments...reflected an uncertain relationship to a past and future that was now to be

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[685] Jackson, *Spectrum of Belief: Joseph Von Fraunhofer and the Craft of Precision Mechanics*, 200.
[686] J. C. V. Hoffmann, "Vom Herausgeber," *Zeitschrift für mathematischen und naturwissenschaftlichen Unterricht* 30 (1900): 2.
[687] Anonymous, *Jahrbuch 1951: 40 Jahre Kaiser-Wilhelm Gesellschaft Zur Förderung Der Wissenschaften 1911-1951* (Göttingen: Generalverwaltung der Max-Planck-Gesellschaft zur Förderung der Wissenschaften, 1951), 122.
[688] *50 Jahre Kaiser-Wilhelm-Gesellschaft Und Max-Planck-Gesellschaft Zur Förderung Der Wissenschaften, 1911-1961: Beiträge Und Dokumente* (Göttingen: Max Planck Gesellschaft, 1961), 81.
[689] Ernst Gerland, "Über Die Anregungen, Die Der Bergbau Im Laufe Der Kulturgeschichte Der Naturwissenschaft Und Technik Hat Angedeihen Lassen," *Archiv für die Geschichte der Naturwissenschaften und der Technik* 2 (1910): 316.

interpreted in terms of a coherent national history."[690] Assessing the fin-de-siècle epoch of the West in general, the German writer and critic Heinrich Hart came close to a description of what he may have viewed as his own nation's peculiar characteristics: "this time of fresh inquiry and exhausted doubt,...of groping and tendency to be misled, of halfway trust in the future and halfway relapse..."[691]

With a still-forming position among the nations in a climate of an increased national rivalries, in which ethnicity, language, laws, economies, military strength, and rites and customs were implicated, the Germans' resort to past and contemporary achievement in science was a means of partially allaying insecurity.[692] The history of German science merged the element of science with the historical dimension, the "laudable past" important in reinforcing national identity.[693] Historical scientific displays brought the history of science to more people than those who would read scholarship on it, reinforcing the Germans' feelings of superiority in science. The important founding fathers of German science, including those of the recent and distant past, were regarded as personalities of national history.[694]

The Germans increasingly maintained a disparaging position on the idea of a continental equilibrium among the Great Powers, now seen as a means whereby Britain disadvantaged Germany.[695] And the sense of rivalry, and a scorn for traits associated with its rivals, extended to not only Britain, but "to a lesser extent, the United States…fitted into the same scheme as a

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[690] Koshar, *From Monuments to Traces: Artifacts of German Memory, 1870-1990*, 32.
[691] Heinrich Hart, Julius Hart, and Wilhelm Bölsche, *Gesammelte Werke*, 4 vols., vol. 3 (Berlin: E. Fleischel, 1907), 88.
[692] Eugène-Melchior de Vogüé, "La Défunte Exposition," Revue des Deux Mondes 4, no. 162 (1900), 380-399 quoted in Brain, *Going to the Fair: Readings in the Culture of Nineteenth-Century Exhibitions*, 165.
[693] Belgum, *Popularizing the Nation: Audience, Representation, and the Production of Identity in Die Gartenlaube, 1853-1900*, 56.
[694] Jakob Vogel, "Georgius Agricola Und Die Deutsche Nation," in *Wissenschaft Und Nation in Der Europäischen Geschichte*, ed. Ralph Jessen and Jakob Vogel (Frankfurt am Main: Campus, 2002), 148.
[695] Hewitson, "*Nation* and *Nationalismus*: Representation and National Identity in Imperial Germany," 56.

utilitarian addition to French rationalism", opposite which was set German *Kultur*.[696] Andreas Daum reinforces this point when he recounts that German physiologist and influential scientific publicist Emil du Bois-Reymond used the term 'Americanism' in his speeches to connote coarse materialism.[697]

Historian Heinrich von Treitschke was but one example of the German polemicists who placed an emphasis on success in competition, avoiding the fate of the Netherlands, reduced in stature, and Poland, which had been annexed. There was a sense by the early twentieth century that Germany must surpass France, Britain and the United States in the realms of learning and politics. Germans supported their nation in its role of a unique alternative to the thought of Britain, France and the United States.[698] There was also a perceived German need to struggle for dominance to offset the favored position that states with either a large footprint in trade or with a huge territory—thus including Russia and the United States, along with Britain—had.[699]

The commentators from the recently-formed German nation adopted brashness as a signal that they meant Germany to be taken seriously by other nations. "The German…is called on…in the world concert of politics to be first violin," hammered home the contemporary augur Julius Langbehn .[700] The German economist Adolph Wagner's proclamation that "[i]f anyone is to be first among equals, then it will be he [the German] and not the Frenchman or the Briton" evidenced a combative spirit of the times and an assertive German stance, determined that the

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[696] Ibid., 27-28.
[697] Andreas Daum, " 'the Next Great Task of Civilization': International Exchange in Popular Science--the German-American Case, 1850-1900," in *The Mechanics of Internationalism: Culture, Society, and Politics from the 1840s to the First World War*, ed. Martin H. Geyer and Johannes Paulmann (London: Oxford University Press, 2001), 289. footnote 8.
[698] Hewitson, "*Nation* and *Nationalismus*: Representation and National Identity in Imperial Germany," 39.
[699] Ibid., 40.
[700] Julius Langbehn, *Rembrandt als Erzieher* (Leipzig : C.L. Hirschfeld, 1890), 239 in Glaser, *Die Kultur Der Wilhelminischen Zeit Topographie Einer Epoche*, 24.

nation be seen as formidable.[701] Collectively the sciences formed a territory of rich opportunities for an actual German dominance. Wilhelm Ostwald was justified in speaking in 1910 of "the unbelievable progress which Germany has made in the domain of research [*auf wissenschaftlichem Gebiete*] [in the past hundred years]"; even his adding "through which it has been brought to the first position in the scientific competition of peoples" was certainly arguable.[702]

By the end of the reign of Wilhelm I, who died in 1888, Germany had attained a degree of power and greatness unprecedented in its history.[703] But it was some years into the reign of Wilhelm II, from 1896, that the German economy again surged. This was the high tide of the "second industrial revolution". Bruno Seidel, writing of this period's economic-mindedness, draws the interesting conclusion that national chauvinism functioned as an important motivator of economic performance—the entrepreneurs saw economic activity as their civic duty and shaped their interests in technology and economy according to a doctrine of outperforming rivals, but equally as the justification favored for self-interested behavior. The concept of the national weal took in colonies, the trade fleet, the level of overseas trade, and navigation.[704] The attempt was made to put technology to work by all participants in the economy. Progress had become a bourgeois byword. By the turn of the twentieth century, the large concerns [*Großbetriebe*] grew strongly in Germany. University-educated technologists, chemists and physicists entered economic life and "technological progress was bureaucratized". "Systematic planning" and "scientific management" became the norm in large firms both technically and

[701] Hewitson, "*Nation* and *Nationalismus*: Representation and National Identity in Imperial Germany," 41.
[702] Wilhelm Ostwald, *Grosse Männer* (Leipzig: Akademische Verlagsgesellschaft, 1909), 419.
[703] Nichols, *The Year of the Three Kaisers: Bismarck and the German Succession, 1887-88*, 131.
[704] Seidel, "Die Wirtschaftsgesinnung Des Wilhelminischen Zeitalters," 179.

financially.[705] A superior economic performance, grounded in strong science, was becoming an identifying and unifying German characteristic, whereas German political arrangements did not keep in step with modernization.[706]

It is incontestable that the German Empire was powerful. But in a climate of international rivalries and intense competition, the nation perceived that it was in peril. Fractures among its citizenry could only be sidelined by a sense of the mainstream German mission to be the best. It was not fortuitous that the nation's publicists and supporters resorted to unifying rhetoric including that about the excellence of German science and of German learning generally. In science, though even there doubts surfaced about its durability, Germany's quest for superiority had apparently been realized.

CONCLUSION

I have addressed the course of events in the German lands during the nineteenth and early twentieth century because science was on the uprise there in this period, and in order to search out instances and junctures in which other developments influenced German science and vice versa. Ultimately, my goal is to show that, while German learning and science could advance so magnificently after the early decades of the nineteenth century due to a variety of factors, the history of science institutionally got underway during the German Empire, whose need for realms of activity that would bring a greater national bridging of differences could get a boost from a commonly-shared pride in science past and present.

The course of German history during the nineteenth century shows remarkable changes. Crucial among these changes was the transition from having been, reduced from its status as a

[705] Ibid., 174-75.
[706] Feuchtwanger, *Imperial Germany, 1850-1918*, xix.

one-time scientific power, for a period of time a secondary scientific environment, to now being once again scientifically superior. To gain a contextual appreciation of how this came to be, I have covered the main outlines of the German historical development during the nineteenth century and on into the early twentieth century. In the following chapter I will treat the ascent of German science proper during this period.

The new powerful Germany's appearance on the world stage while its political institutions were not fully developed for the modern era indicated the tensions Germany faced itself and the problems it caused its fellow major powers. The people—whose destiny seemed so dimmed in 1806 with the French routing of Prussia at Jena—were showing themselves capable of great things late in the century—but their road to the future was marked by persistent questions.[707] The German Empire, to the end, was autocratic and riven by the ascription of an outsider status to various groups within the Empire. The Germans participated in sharpened international rivalries, notably now increasingly with Britain as well as with long-time foe France. The Germans were summoned to war again in 1914 under the sign of an undeniable world-power status. That protracted war ended in the dissolution of the German Empire, and set the stage, twenty-five years later, for the resumption of total war, in a Second World War that ended with the dismemberment of Germany.

[707] Wehler, "Wie Bürgerlich War Das Deutsche Kaiserreich?," 244. David Blackbourn, "Kommentar Von David Blackbourn," in *Bürger Und Bürgerlichkeit Im 19. Jahrhundert*, ed. Jürgen Kocka (Göttingen: Vandenhoeck & Ruprecht, 1987), 286-2 87.

CHAPTER V:
THE ARC OF THE RISE OF GERMAN LANDS TO SCIENTIFIC PRE-EMINENCE

This chapter is centered on the role of nineteenth century science, including those many areas where the Germans were doing leading work. The principal points it makes are that without the eminence in contemporary science, new German interest during the Empire in the history of science would probably have been much curtailed, that the need for the sense of a tradition to shore up and bridge divides within the new German nation was a favorable basis for the increased activity in the history of science, that the government of Germany during the Empire (like the governments of the various German lands in most cases for several decades before 1871) was a big rhetorical and financial supporter of science, and that the Germans identified diligence and precision in science as characteristic traits of their people. The sources utilized encompass a wide variety of primary and secondary sources to interrogate the achievements and the point of view of German Empire scientists and the public about the German scientific enterprise and to extract conclusions on how national rivalries, as well as the national self-image in formation, led to the Germans' during the Empire, especially the bourgeois Germans', endowing science with superordinate importance. The sources for this chapter have been Franz Schnabel's general German nineteenth century history, John Theodor Merz's intellectual history of the nineteenth century, monographs, contemporary journal articles, collections of essays, a world's fair catalogue, the transactions of a present-day congress, a publication of the Berlin Urania *Weltall*, early biographies and speeches, a house publication of the Deutsches Museum, the journal of the Society of German Engineers, a commemorative volume of the late Empire, and a recent dissertation.

As premised above, the rationale for including such a chapter in this dissertation stems from what I maintain is a link between the level of science reached in the nineteenth century, with its manifold discoveries and its "scientific army" of practitioners, and the spike in the activity in the history of science in Germany and elsewhere, including the innovation of displays of the history of science. This chapter, by outlining the role of nineteenth century science, the important role of science in national self-image, and the German bourgeoisie's active relationship with nineteenth century science, and taken along with the part of the previous chapter sketching the movement towards a politically unified German nation, and with the next chapter on nineteenth century German predilection for history, allows representation of what I judge to be the main contributing factors associated with the German precedence in the formation of a history of science discipline.

The justification for this chapter's focus on *contemporary* scientific achievement is thus the position I take that only with the current scientific primacy would accounts of *past* German science have had much hold on the German people by their contribution to a sense of national tradition and identity. Germans took very seriously, during the second half of the nineteenth century, the idea that their character was inherently scientific—indeed, that they were the world's most scientific people. For the full proof of this grandiose, if arguable, conception, present-day primacy in science would not suffice; it was also necessary to have the proofs of a past German scientific greatness.

Within this chapter, I first relate the general nineteenth century expansion of scientific research in the world's most politically and economically developed nations. Next, I trace the German scientific activity over the centuries. I note the relationship of organized German science (in the form of the annual meetings of German Natural Scientists and Physicians) to the German

national movement. I depict the surge during the second two-thirds of the nineteenth century in German science from a secondary position to that of foremost in the world. I consider the importance of the German university setting for the advance of science, noting the differentiation of some branches of science into new disciplines in German universities.[708] I follow the bourgeoisie's interests and involvement in the advance of science, a prelude to my claim later in the dissertation that the bourgeoisie was the principal source from which emanated the German interest in the history of science. Science became one of the principal seats of late nineteenth century national rivalries, which I detail. I also treat the place of science as a cultural force in Germany, in part through its popularization in multiple forms.

By the end of the nineteenth century, German science was second to none. It was in this context that the first German historical scientific displays took place. Not only was cutting-edge contemporary science central to some nations' view of themselves, but also a strong scientific tradition. Referring to the present day, Carol Harrison and Ann Johnson recently held that

> [t]he national imaginary often defines that future in terms of scientific and technological achievement. As nations cultivate the camouflage of ancient tradition, they simultaneously celebrate their scientific character, which they present as unprecedented. The unique achievement of the nation, they maintain, lies in its citizens' scientific competence, their position on the cutting edge of discovery. We argue, then, that national identity is rooted in a tradition of invention as well as in the invention of tradition.[709]

In a former period, one could hardly find a better example of how scientific achievement in the present and past worked together towards the formation of national identity than the national imaginary of the German Empire.

[708] Ringer, *The Decline of the German Mandarins: The German Academic Community, 1890-1933*, 53.
[709] Harrison and Johnson, "Introduction: Science and National Identity," 4.

THE NINETEENTH CENTURY RISE OF SCIENCE GENERALLY

The German nineteenth century advance in science was part of the expansion of science into a place of great prominence generally in Western nations. David Knight, the distinguished historian of science, has written of the Western nineteenth century that

> scientific ideas [were]…the leading ones: other fields reacted to science. And in that century of newspapers, telegraphs, and education for all, the history of ideas is central…[participants] wrote about it in…general publications, they spoke about it at public meetings; it was popular science which was disseminated…
> …[T]he nineteenth century became the Age of Science partly because in those years it became not merely an intellectual activity, but…an agent, as prophesied, in changing society.[710]

Historians Elisabeth Crawford, Terry Shinn, and Sverker Sörlin premise that

> ...in the 19th and 20th centuries...science and technology were consciously transformed [by nation-states] into a structured and intermeshing system intended to enhance the capacity of the central government to exercise coordination and control over increasingly numerous spheres of public and private activities.[711]

Use of the model of science to inform the other realms of private and public life dilated impressively. The British-German John Merz, in his famous four-volume intellectual history of the past century, wrote at the turn of the twentieth century that, by the end of the previous century, "[t]he same mathematical spirit which governs scientific methods rules also in trade, commerce, and industry, and is gradually penetrating into the professions, such as medicine, law, and administration."[712]

There was a great expansion of the forces conducting research in Western lands in general in the nineteenth century, wherein the "invention of the method of invention" led to

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[710] David M. Knight, *The Age of Science: The Scientific World-View in the Nineteenth Century* (New York: Basil Blackwell, 1986), 6, 9.
[711] Elisabeth T. Crawford, Terry Shinn, and Sverker Sörlin, "An Introductory Essay," in *Denationalizing Science: The Contexts of International Scientific Practice*, ed. Elisabeth T. Crawford, Terry Shinn, and Sverker Sörlin (Boston: Kluwer, 1993), 10-11.
[712] John Theodore Merz, *A History of European Thought in the Nineteenth Century: Scientific Thought*, 4 vols., vol. 1 (London: William Blackwood, 1896), 19, 90.

incomparable advances.[713] Whether in chemistry, thermodynamics, electromagnetism, Darwinian biology, cell and embryonic science, and in the final decades evacuated tube technology, science made momentous surges forward in the nineteenth century. Theodor Schieder writes, "[t]he political national state,…the institutionalizing of science and its recognition as norm-giving authority go hand in hand[…]" during this historical period.[714]

The remarkable and very publicly visible technological deeds of the nineteenth century called forth wide interest in science and technology in the public mind.[715] People were fascinated by new capabilities such as color and flash-lamp photography, recorded sound, transmission of electromagnetic waves, wireless telephony, and cinema. Even X-ray demonstrations proved to have the allure of a midway stall, with people lining up to see phantom images of their own limbs.[716] And engineering projects, which had in previous decades already generated public enthusiasm, such as the tunnel under the Thames in London (constructed 1824-1843), continued to be headline items. The start of the work on the Simplon Tunnel in the Alps between Switzerland and Italy in 1898 was a public event of great interest. Natural events, to a population entranced with science, also created an unprecedented interest and a desire for information. Events such as the 1878 Transit of Venus, the 1883 explosion of the Pacific island of Krakatoa, and the 1912 solar eclipse drew a widened awareness of scientists' role in understanding large-scale natural phenomena.

For all the pockets in Germany of great excitement about science, some of which extended to the history of science, nonetheless, there were also nay-sayers. Christoph Meinel

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[713] Schwarz, *Der Schlüssel Zur Modernen Welt: Wissenschaftspopularisierung in Grossbritannien Und Deutschland Im Übergang Zur Moderne (Ca. 1870-1914)*, 63-64.
[714] Theodor Schieder, "Kultur, Wissenschaft Und Wissenschaftspolitik Im Deutschen Kaiserreich," in *Medizin, Naturwissenschaft, Technik Und Das Zweite Kaiserreich: Vorträge Eines Kongresses Vom 6. Bis 11. September 1973 in Bad Nauheim*, ed. Gunter Mann and Rolf Winau (Göttingen: Vandenhoeck & Ruprecht, 1977), 30-1.
[715] As witness the attention devoted to technology attested to in Belgum, *Popularizing the Nation: Audience, Representation, and the Production of Identity in Die Gartenlaube, 1853-1900*, 55.
[716] Paul Spies, "Über Roentgensche Strahlen," *Himmel und Erde* 8 (1896): 258.

speaks of "tectonic stresses" in that period in Germany between a belief in progress and a cultural pessimism regarding materialism and the loss of old values.[717] Scientists then as now needed to be spokesmen for the value of science. Werner von Siemens, in a prominent 1886 speech, said that

> the problem set me today…consists in helping to dissipate the apprehensions which latterly have frequently been made public with respect to scientific technical progress."[718] "[I]n recent times...melancholy pessimistic views...have been formed both in educated circles as well as among the masses, respecting the influence which the rapid development of science and engineering exerts, on the formation of the life of the people, and on the final aim of this advancement.[719]

Siemens finished, however, by validating the surge of science:

> [I]t would, however, be useless to attempt to interrupt the current of this advance, or to wish to turn back… [Science's] peaceful advancement...however, really leads mankind to better conditions...in its further progress it will again heal the wounds which it struck... Equally unfounded is the complaint that the study of science and the technical application of the forces of nature gives to mankind a thoroughly material direction...and alienates ideal endeavours. The deeper we penetrate into the harmonious action of natural forces regulated by eternal unalterable laws...the more we feel on the contrary moved to a humble modesty...the more active is our endeavour to draw more from the inexhaustible fountain of knowledge, and understanding, and the higher rises our admiration of the endless wisdom which ordains and penetrates the whole creation.[720]

It was thus incumbent on scientists to represent their endeavors and contributions to the general culture in a positive, non-alienating way (a task that was the precursor to today's public engagement with science.)

THE LUSTROUS PAST OF GERMAN SCIENCE AND ITS NINETEENTH CENTURY REVIVAL

The contemporary strength of German science in the second half of the nineteenth century and through the end of the Empire in 1918 had its match in certain earlier periods.

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[717] Meinel, *Karl Friedrich Zöllner Und Die Wissenschaftskultur Der Gründerzeit: Eine Fallstudie Zur Genese Konservativer Zivilisationskritik*, 13.
[718] Werner von Siemens, "The Age of Natural Science," in *Scientific & Technical Papers of Werner Von Siemens* (London: J. Murray, 1892), 511.
[719] Ibid., 514.
[720] Ibid., 516, 18.

German science was particularly famed in the fifteenth and sixteenth centuries. Otto Witt, writing on behalf of Germany for the 1893 Chicago World's Fair, declaimed: "Germany is conscious of her national independence…she has, with restless industry, built up the edifice of the traditions of former days."[721] Among the great previous traditions was that of German science. In the fifteenth century, Georg Peurbach designed astronomical instruments and Regiomantus created astronomical, navigational, and time-keeping instruments, and both Peurbach and Regiomantus wrote mathematical treatises, while at the end of the century Martin Behaim produced a world-renowned globe as well as navigational charts and instruments aiding Christopher Columbus's New World voyages.[722]

In the sixteenth century, there was additional outstanding German scientific work including that of the metallurgist Agricola, that of the physician and (al-)chemist Paracelsus and that done in the astronomical collaboration between the ruler Wilhelm IV of Hesse-Cassel and the world-famous Danish astronomer Tycho Brache. That century also saw the important cartographic works of Gerardus Mercator, Peter and Philipp Apian, and Johannes Schöner, which banked the new knowledge gained by the European explorers. The Germans also excelled in the production of other scientific instruments, such as of sun-dials at Nuremberg. The combined German scientific achievement in these two centuries was of a high order, measured against the best work being done contemporaneously in science elsewhere.

With important exceptions, however, in German lands the seventeenth and eighteenth centuries overall were not rife with leading scientific work—the palm had passed elsewhere. German lands suffered immense privations in the Thirty Years War (1618-1648) and the calamity had a depressing effect on social welfare there that lasted decades past the conflict

[721] Witt, "Einleitung," i [no actual pagination].
[722] John G. Morris, *Martin Behaim, the German Astronomer and Cosmographer of the Times of Columbus* (Baltimore: Murphy, 1855), 12.

itself. Despite the presence in Berlin of the *Académie Royale des Sciences et Belles Lettres* (Royal Academy of Sciences and Literary Works) from 1700 when Leibniz founded it, and its reorganization in 1744 by Frederick the Great, the great German eighteenth century scientists and mathematicians were a few renowned individuals rather than a whole cadre of practitioners. As the eighteenth gave way to the nineteenth century, German science had for the most part been in the doldrums except at a few sites such as Göttingen University. The German lands had only limited traces of their once high repute in the sciences.

Thus, there was great significance in the fact that already before mid-nineteenth century, a comeback of German science to prominence took place. A précis here lays out the state of German science in the first half of the nineteenth century and the achievement of a special role for German science from its second half on through to the end of the Empire.

The difference between the characteristic lines of German science of the beginning and end of the century itself bore the imprint of much social reconfiguration during those years. Besides this, there were instances where the methods and achievements of science and technology directly or indirectly influenced the larger social framework. That Germany appeared so different in the years of its Empire from the form of the German lands at the start of the nineteenth century was due in part to the material and cultural effects of German science and technology in the intervening decades. Certainly the most striking of the changes, as Timothy Lenoir claims that recent scholarship has shown, is that "its investment in scientific and technical education was one of the most significant factors in the meteoric rise of imperial Germany to the first rank among world powers at the end of the nineteenth century."[723]

[723] Timothy Lenoir, "Science for the Clinic: Science Policy and the Formation of Carl Ludwig's Institute in Leipzig," in *The Investigative Enterprise: Experimental Physiology in Nineteenth-Century Medicine*, ed. William Coleman and Frederic L. Holmes (Berkeley: University of California, 1988), 140.

At the turn of the century there were several German states, among them Prussia and Baden, in which representatives of the middle class populated the state bureaucracies, as Richard Olson notes, and these individuals, having received training in administration and management (at that time termed "cameralist science"), were in favor of scientific education and of the application of science to industry. Otherwise said, despite a rural population and an agricultural economy, the groundwork was put in place for a spring forward in sciences in certain German states.[724] It was primarily during the first half of the century that the basis for later German world leadership in sciences was laid. References for the rise of German science in the first half of the nineteenth century (from 1820) can be found in an article by Bastiaan Willink.[725]

In the first two decades of the nineteenth century there was a near-craze in German lands for *Naturphilosophie*, a doctrine embracing natural knowledge whose tendencies included some doubtful ideas about physical phenomena, such as that they *all* displayed polarity. After 1820 the high tide of the *Naturphilosophie* movement had started to recede.[726] For all its vagaries, the passion with which it was for a time embraced presaged the subsequent renewed elevation of the cultural standing of, and the great resources devoted to, science in the German lands.

Director of Cultural Affairs Wilhelm von Humboldt's stipulation of a new direction in 1810 for the just-founded University of Berlin set the stage for an emphasis on research, initially in the humanities, throughout German universities. Research activity became mandatory in order for docents to ascend up the promotion scale at the university. Although Humboldt held his position for just a year, the carefully reasoned plan he set out for the University of Berlin

[724] Olson, *Science and Scientism in Nineteenth-Century Europe*, 299.
[725] Bastiaan Willink, "On the Structure of a Scientific Golden Age," *Berichte zur Wissenschaftsgeschichte* 19 (1996): 38.
[726] Michael Hagner, "Scientific Medicine," in *From Natural Philosophy to the Sciences: Writing the History of Nineteenth-Century Science*, ed. David Cahan (Chicago: University of Chicago Press, 2003), 59. Iwan Rhys Morus, *When Physics Became King* (Chicago: University of Chicago Press, 2005), 70, 76-77, 85-86.

strongly influenced the subsequent faculty recruitment practices at the German-language universities. The world-renowned German student and professorial research soon included the natural sciences and medicine.[727] According to Josef Ben-David, natural

> scientists in a number of fields started to develop into much more closely knit networks than ever before. Their nuclei were now university laboratories training large numbers of advanced students, thus establishing between them personal relationships, highly effective means of communication, and the beginnings of deliberately concentrated and coordinated research efforts in a selected problem area.[728]

Ben-David goes on to assert that

> [t]he transformation of science into a status approaching that of a professional career and into a bureaucratic organized activity took place in Germany between 1825 and 1900. By the middle of the nineteenth century, practically all scientists in Germany were either university teachers or students, and they worked more and more in groups consisting of a master and several disciples.[729]

In the course of the nineteenth century, well before unification in 1871, the sciences' lagging situation at the start of the century in the majority of the German universities had advanced in a steadily progressing manner. The universities, supported by the individual German states, increasingly became centers of scientific research as well as of training in science—both professors and students did research.

Beginning in 1817, a strong start in the training for scientific medicine had already been made at Würzburg Clinic by Johann Schönlein, docent at that city's university, while from 1824 Liebig prepared research students at Giessen University, in the 1820s private tuition groups were in place for mathematics and most sciences at Halle University, and a natural sciences seminar was initiated at Bonn University in 1825 and a mathematics seminar at Münster in 1831. A

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[727] Bernhard Vom Brocke, "Die Kaiser-Wilhelm-/Max-Planck-Gesellschaft Und Ihre Institute Zwischen Universitat Und Akademie. Strukturprobleme Und Historiographie," in *Die Kaiser-Wilhelm-/Max-Planck-Gesellschaft Und Ihre Institute : Studien Zu Ihrer Geschichte*, ed. Bernhard vom Brocke, Hubert Laitko (Berlin: De Gruyter, 1996), 5. Also, Sheehan, *German History, 1770-1866*, 516.
[728] Joseph Ben-David, *The Scientist's Role in Society: A Comparative Study* (Englewood Cliffs, N.J.: Prentice-Hall, 1971), 125.
[729] Ibid., 108.

mathematics-physics seminar was created at Königsberg University in 1834, at Halle in 1838, and at Göttingen in 1850, a natural sciences seminar (supplementing the mathematical-physical seminar already begun there) opened at Königsberg University in 1835, and a mathematics and natural sciences seminar began work in Freiburg in 1846.[730] In 1839 physiologist Jan Purkyne headed up the world's first university department of physiology in the at that time German-language University of Breslau, part of the branching in the German universities from longer-standing scientific disciplines into new disciplines; three years later the world's first institute specializing in microscopical research was formed there. By 1880, nine years after establishment of the German Empire, all but one of Europe's twenty-seven German-language universities had a chair in physiology, the majority of them with an attached research institute.[731]

During the early decades of the century, German scientific names retained or gained international renown. Carl Gauss was perhaps the world's most universal mathematician who also did important work in geomagnetism and the telegraph. Chemists, then physiologists, and then physicians caught up with or overtook counterparts in France and elsewhere.[732] French chemists began in the early 1830s to lament that "all light is now coming" from German laboratories.[733] The chemist Justus von Liebig, the embryological theorist Karl Ernst von Baer, the physiologist Johannes Müller, the physiologist-cellular theorists Theodor Schwann and

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[730] Franz Schnabel, *Deutsche Geschichte Im Neunzehnten Jahrhundert -- Erfahrungswissenschaften Und Technik*, 4 ed., 4 vols., vol. 3 (Freiburg im Breisgau: Herder, 1948), 225. Walter Langhammer, "Some Aspects of the Development of Mathematics at the University of Halle-Wittenberg in the Early 19th Century," in *Epistemological and Social Problems of the Sciences in the Early Nineteenth Century [Papers from a Workshop Held at the Univ. Of Bielefeld, Nov. 27-30, 1979]*, ed. H. N. Jahnke and Michael Otte (Dordrecht: Reidel, 1981), 242. Christa Jungnickel and Russell McCormmach, *Intellectual Mastery of Nature -- Theoretical Physics from Ohm to Einstein: The Torch of Mathematics, 1800-1870*, 2 vols., vol. 1 (Chicago: University of Chicago Press, 1986), 79. Gert Schubring, "Der Mathematische Seminar Der Universität Münster, 1831/1875 Bis 1951," *Sudhoffs Archiv* 69, no. 2 (1985): 164-65.
[731] R. Steven Turner, *In the Eye's Mind: Vision and the Helmholtz-Hering Controversy* (Princeton: Princeton University Press, 1994), 244.
[732] Schnabel, *Deutsche Geschichte Im Neunzehnten Jahrhundert -- Erfahrungswissenschaften Und Technik*, 224.
[733] citation from Alan J. Rocke, *Nationalizing Science: Adolphe Wurtz and the Battle for French Chemistry* (Cambridge, MA: MIT Press, 2001), 271.

Matthias Schleiden, and the physiologist/physicist Hermann von Helmholtz already in his early work brought laurels to German lands. In Liebig's own words in 1840:

> In the natural sciences, Germany [*sic*] has again taken the place that nature has accorded her. A mass of intelligence pulses through our numerous universities, in the arteries of so many states, which secure for their scientists the most complete independence…From Germany has come the impulse of progress in all the natural sciences of modern times.[734]

In addition to the practice of the elite German science, almost completely enacted at universities, another substratum of scientific interest and activity arose. Panagiotis Kitmeridis and Ayako Sakurai remind us that the bourgeois voluntary associations devoted to the study of nature—including formation of amateur collections—whose support came from private patronage also made up part of the scientific social landscape.[735] The local scientific societies in German towns, joining together medical, naturalist and exact scientific interests under the rubric of a unified science, and multiplying particularly in this period, had gotten their start in the 1810s and 1820s.[736] The founding in 1824, in a city without a university, of the Frankfurt Physical Society, pursuing both research in and popularization of physics (principally electrotechnology), chemistry, meteorology, geology and astronomy was due to the bourgeoisie and earned for its city substantial renown.[737]

Among the new upper-(but not university-based) bourgeois led enterprises associated with science and technology by mid-century were "the public zoo, park, botanical garden, industrial exhibition and museum…"[738] Additionally, what Denise Phillips calls "second-tier cultural centers" composed of provincial/regional natural historical societies formed particularly in the 1830s and 1840s in a number of German provincial centers and other towns. Such "civic"

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[734] citation from Ibid., 339.
[735] Panagiotis Kitmeridis, "Popularisierung Der Naturwissenschaften Am Beispiel Des Physikalischen Vereins Frankfurt" (Hamburg University, 2014), 142. Sakurai, *Science and Societies in Frankfurt Am Main*, 5.
[736] Phillips, *Acolytes of Nature: Defining Natural Science in Germany, 1770-1850*, 179.
[737] Kitmeridis, "Popularisierung Der Naturwissenschaften Am Beispiel Des Physikalischen Vereins Frankfurt", 142.
[738] Kathryn Olesko, "Science in Germanic Europe," Guset User, http://fliphtml5.com/ivse/fwst/basic. : 12.

societies were primarily centered on collecting, usually in local terrain, and on publishing their findings as "natural history news". Socially, their members included physicians but drew heavily on the fringe middle-class—schoolteachers, printers, engravers, clerks and librarians, purveyors of natural history specimens, and engineers—rather than on the upper social echelons more common in the German university science.[739] Rooted in the non-elite bourgeoisie, forty-five German local societies dedicated to the general pursuit of natural scientific topics had been established by 1850.[740]

A diverse landscape of societies and associations fostered a widened acquisition of scientific knowledge, some becoming important sites of scientific investigation, scientific popularization, or both.[741] All this non-elite scientific activity further contributed to the spread of an awareness of, and an appreciation for, the advance of science.

GERMAN SCIENTIFIC ASCENDANCY

By some point during the second half of the nineteenth century, it was Germany (before 1871 the combined set of German states) which was widely held to be the land of science.[742] There was a national ethos of German *Wissenschaft* (learning) that by 1860 (and two or three decades earlier in certain sciences) included and even applied most fully, to the natural sciences.[743] After 1871, the German citizens, proud of their new nationhood, saw scientific advances and advances in all the branches of learning, like increases in production and success on the battlefield, as something that they could claim as characteristic of the Empire. Just as the

[739] Phillips, *Acolytes of Nature: Defining Natural Science in Germany, 1770-1850*, 179.
[740] Ibid., 8.
[741] Kitmeridis, "Popularisierung Der Naturwissenschaften Am Beispiel Des Physikalischen Vereins Frankfurt", 252.
[742] Schwarz, *Der Schlüssel Zur Modernen Welt: Wissenschaftspopularisierung in Grossbritannien Und Deutschland Im Übergang Zur Moderne (Ca. 1870-1914)*, 91.
[743] Sander Gliboff, *H.G. Bronn, Ernst Haeckel, and the Origins of German Darwinism : A Study in Translation and Transformation* (Cambridge, MA: MIT Press, 2008), 61.

present-day German eminence in science was an important rallying-point within an overall emphasis on modernization, details of the distinguished past could be recited to build up the sense of nation.[744] A point of pride was that German science, past and present, had shown uncommon brilliance.

Prominent German chemist August von Hofmann wrote in 1878 that "science had found a dispersion in Germany like no other land."[745] Werner von Siemens, great German industrialist-scientist, attesting to the increased role of science especially in Germany, wrote in 1884 that "[t]he patronage of natural scientific research is thus in eminent degree a support of the material interest of the nation."[746] Wilhelm Treue assesses the 19th century in Germany as the juncture at which various aspects of the scientific enterprise, its motivations, politics, and finance and its application to economic activity, were combined to a degree and with an output never before reached anywhere.[747]

The German historian of science Frank Linhard asserts that the many scientific advances by the Germans were received with acclaim by the lay public, and that the German scientific endeavor was promoted by the entire national culture.[748] As Bernhard vom Brocke notes, such was the emphasis put on *Bildung* (cultural development) and knowledge in Germany that, beginning in the final third of the nineteenth century, together they were held up alongside

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[744] Belgum, *Popularizing the Nation: Audience, Representation, and the Production of Identity in Die Gartenlaube, 1853-1900*, 56. Hobsbawm and Ranger, *The Invention of Tradition*.
[745] Hofmann, "Vorwort," viii.
[746] Emil Warburg, "Werner Siemens Und Die Physikalisch-Technische Reichsanstalt," *Naturwissenschaften* 4, no. 50 (1915): 795.
[747] Wilhelm Treue, "Vorwort Des Herausgebers," in *Wissenschaftspolitik Im Wilhelminischen Deutschland : Vorgeschichte, Grundung Und Aufbau Der Kaiser-Wilhelm-Gesellschaft Zur Forderung Der Wissenschaften*, ed. Lothar Burchardt (Gottingen: Vandenhoek and Ruprecht 1975), 5.
[748] Frank Linhard, "Zur Situation Der Naturwissenschaften in Der Zweiten Hlfte Des 19. Jahrhunderts," in *Historisierung Und Gesellschaftlicher Wandel in Deutschland Im 19. Jahrhundert*, ed. Ulrich Muhlack, Christian Mehr, and Dagmar Stegmüller (Berlin: Akademie-Verlag, 2003), 174. Jackson, *Spectrum of Belief: Joseph Von Fraunhofer and the Craft of Precision Mechanics*, 211.

capital, land, and labor as the nation's fourth factor of production.[749] By that time, scientific knowledge was arguably the domain in which Germany excelled most resoundingly. The command of learning was part of what Andreas Daum calls bourgeois consolidation, identity construction, and aestheticization of knowledge.[750]

The bourgeoisie built its connections to science as it undertook to lead Germans as a whole in more and more realms. There is some variation in scholars' assessment of the juncture at which the bourgeoisie takes up and takes over espousal of the ideal of scientific rationality. German historical specialist James Sheehan locates in the mid-eighteenth century the earliest adoption of a distinct set of values by the people most successful in commerce and bureaucracy, in contrast to the values of the nobility. The former were headed by knowledge attainment, fulfillment of tasks, and satisfaction of duties. The indices for success in the achievement of these moral directives were profits, promotions, and results from examinations. The performance ethic of the bourgeoisie required both initiative and discipline. Among its predilections were the cultivation of science and art, earnestness, and a cult of the private realm of the bourgeois family.[751] Kathryn Olesko shifts the adoption of rationality by the bourgeoisie to the mid-nineteenth century.[752] Christian Geulen simply rephrases Pierangelo Schiera that during the nineteenth century, the natural sciences, with their principles of "truth, law, and order", were one of the channels most characteristically used by the bourgeoisie to effect a representation of itself as a class.[753] The regnant middle class was satisfied that it was responsible for that development

[749] Vom Brocke, "Das Elend Der Wissenschaftsgeschichte in Deutschland -- Zur Entwicklung Der Wissenschaftsgeschichte Seit Ranke, Insbesondere Im 20. Jahrhundert," 3.
[750] Daum, "Naturwissenschaften Und Öffentlichkeit in Der Burgerlichen Gesellschaft: Zu Den Anfängen Einer 'Popularwissenschaft' Nach Der Revolution Von 1848," 89.
[751] Sfedu, "Musemsgründung Und Bürgerliches Selbstverständnis: Die Familie Leiner Und Das Rosgartenmuseum in Konstanz", 6.
[752] Olesko, "Science in Germanic Europe." : 10-11.
[753] Christian Geulen, "'Center Parcs': Zur Bürgerlichen Einrichtung Natürlicher Räume," in *Der Bürgerliche Wertehimmel: Innenansichten Des 19. Jahrhunderts*, ed. Manfred Hettling and Stefan-Ludwig Hoffmann

of science in the nineteenth century. The bourgeoisie could utilize its connections to science to underline its character as the generator of modernization.[754]

The degree to which the bourgeoisie, and especially its scientific practitioners, viewed their ideals and pursuits as desirable and suitable to instruct *all* sectors of society comes across in the physicist Leo Graetz's assessment of the Deutsches Museum in 1906, just as it does later in its founder, engineer Oskar von Miller's, own testimony—both Graetz and von Miller were the sons of fathers of notable bourgeois achievement, a historian and a monumental sculptor respectively. Graetz felt that

> [t]he objects of the museum…should as far as possible speak out to the person apprehending them…The opportunity should be presented to anyone who wants to learn more closely about [the design and operation of] any of the museum's objects, the museum should enable in outline an inspection-instruction (*Anschauungsunterricht*) and so contribute to the technical and scientific cultivation of the people.[755]

Consistent with Graetz's view, Miller wrote in 1929 that the museum should serve as a place of *Volksbelehrung* and *Volksbildung*, or instruction and cultivation for the people where "the people" meant in this instance those who were explicitly not scientific specialists or beneficiaries of a higher education.[756]

German science in the second half of the nineteenth century not only received entrepreneurs' and the general (but especially bourgeois) public's approbation; there was a support forthcoming from high places. A massive new expansion in German science occurred in the 1860s.[757] From mid-century, increasingly, the university institutes for chemistry, physics, physiology and other scientific disciplines were provided by the state with facilities and

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(Göttingen: Vandenhoeck & Ruprecht, 2000), 260. Pierangelo Schiera, *Laboratorium Der Bürgerlichen Welt: Deutsche Wissenschaft Im 19. Jahrhundert* (Frankfurt am Main: Suhrkamp, 1992).

[754] Wehler, "Wie Bürgerlich War Das Deutsche Kaiserreich?," 274.

[755] Leo Graetz, "Die Bedeutung Und Die Aufgabe Des Deutschen Museums," *Allgemeine Zeitung*, no. 263 Beilage (1906): 290. Miller, *Technische Museen Als Stätten Der Volksbelehrung*.

[756] Miller, *Technische Museen Als Stätten Der Volksbelehrung*.

[757] Lenoir, "Laboratories, Medicine and Public Life ", 39.

operating costs. By 1860, Germany had seized the leadership in organic chemistry, physiology, physics, and some areas of mathematics.[758] The culture of labor, or the industrial classes, in the late nineteenth century also promoted the knowledge about and the conviction of the benefits of science.[759]

In terms of the creation of a scientific infrastructure that could support the rise of Germany to the position of an economic and industrial giant, Timothy Lenoir has argued that the development of more fully outfitted institutes in the late 1860s onward connoted a shift in emphasis, from one on the production of elite scientists to one on amassing a larger body of scientists made up, as du Bois-Reymond expressed it, of "the person of average intelligence, indeed…the person of lesser ability", capable of moving forward the project of a modernizing Germany.[760] Within this scheme, Justus von Liebig had been prescient in emphasizing methods along with factual knowledge to his students in his Giessen lab of the 1830s. For the institutional enlargement from the 1860s, it became common to take an "approach…conducive to the sustained development of research skills, techniques, and instrumentation…and of refining them so that through laboratory training they would enter the repertoire of standard practice."[761] Thus was a partial attitudinal shift marked from *Naturwissenschaft selbst willen* (natural science pursued for its own sake) to science arranged for the achievement of practical results—among them, an increase in German power.

The factors leading to the support of science by the German states before unification, and by the Empire and its constituent *Länder* after unification, included the momentum of German industrialization, increased wealth, policies favoring modernization, advance in the numbers of

[758] R. Steven Turner, "Commentary," *Osiris, 2nd series* 5 (1989): 297.
[759] Richard Evans, *Death in Hamburg: Society and Politics in the Cholera Years, 1830-1910* (Oxford: Oxford University Press, 1987), 104.
[760] Lenoir, "Science for the Clinic: Science Policy and the Formation of Carl Ludwig's Institute in Leipzig," 142.
[761] Ibid., 147-49.

students, and scientific competition between German polities."[762] The German ministries acted to support science both because they took care for the intellectual capital of their states and because they anticipated the material advances from natural science and medicine.[763] During the German Empire, the government continued and heightened the prestige that was accorded to scientific achievement.

Fraunhofer, Reichenbach, and Liebig and were some of the German scientists who were ennobled pre-unification. During the period of the Empire, more scientists, particularly scientists engaging in work with practical consequences, received titles of nobility, among them Hermann Helmholtz, August Wilhelm Hofmann and August Kekulé, and the influential hygienist Max von Pettenkofer. Other scientists might be made *Geheimrat* (translated as Privy Councillor, the designation could be given to people of an outstanding rank in government or sometimes academia) or might join in sociability with the political elite.[764] There were busts of the chemists August Wilhelm von Hofmann and Kekulé installed at the National Gallery in Berlin.[765]

As Germany unified in 1871, Germany was entering a period distinguished above all by its natural science.[766] Natural sciences became of ever greater significance politically and economically in Germany.[767] As the nineteenth century progressed, in a number of scientific fields the German research productivity reached a level not matched elsewhere, due to the "sheer concentration of effort" as leading German investigators worked with the world's most

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[762] Rocke, *Nationalizing Science: Adolphe Wurtz and the Battle for French Chemistry*, 397.
[763] Armin Hermann, "Wissenschaftspolitik Und Entwicklung Der Physik Im Deutschen Kaiserreich," in *Medizin, Naturwissenschaft, Technik Und Das Zweite Kaiserreich: Vorträge Eines Kongresses Vom 6. Bis 11. September 1973 in Bad Nauheim*, ed. Gunter Mann and Rolf Winau (Göttingen: Vandenhoeck & Ruprecht, 1977), 59.
[764] Ringer, *The Decline of the German Mandarins: The German Academic Community, 1890-1933*, 38. Alan Beyerchen, "On the Stimulation of Excellence in Wilhelmine Science," in *Another Germany: A Reconsideration of the Imperial Era*, ed. Jack R. Dukes and Joachim Remak (Boulder, CO: Westview, 1988), 161.
[765] Birt, *Deutsche Wissenschaft Im 19. Jahrhundert: Eine Rede Zur Jahrhundertwende, Gehalten Am 9. Januar 1900*, 9.
[766] Cahan, "The Institutional Revolution in German Physics 1865-1914 ": 39.
[767] Kathryn Olesko, "Physics Instruction in Prussian Secondary Schools before 1859," *Osiris, 2nd series* 5 (1989): 94.

accomplished students in their disciplines.[768] At the turn of the twentieth century, Germany continued to be in the world-leading position in natural science.[769] There were German successes in every area of research.[770] In 1900, Germany led the world in research in physiology (including plant and animal physiology) and chemistry, in mathematics, as well as in precision-mechanical and medical and scientific instrumentation.[771] It was the leading nation in physics, and in the related field of electrotechnology.[772] German optics were foremost through the successful full mathematical rendering of optical device fabrication by Ernst Abbe. The German pharmaceutics were the most developed anywhere in the world.

The reach and excellence of German science was viewed enviously from abroad, with particularly scientists from Britain noting the German strength from the 1860s. Leading British scientific publicists such as Thomas Huxley, Henry Roscoe, and Edward Frankland referred to German science's formidable achievements. Beginning in the middle of the nineteenth century, the Germans were increasingly able to view with pride that their lands had become a destination in certain disciplines for foreigners eager to learn science from its most advanced practitioners. As well, the German model of scientifically-based medical education found adherents among

[768] Ben-David, *The Scientist's Role in Society: A Comparative Study*, 124.
[769] Kanz, *Nationalismus Und Internationale Zusammenarbeit in Den Naturwissenschaften: Die Deutsch-Französischen Wissenschaftsbeziehungen Zwischen Revolution Und Restauration, 1789-1832 Mit Einer Bibliographie Der Übersetzungen Naturwissenschaftlicher Werke*, 32. Birt, *Deutsche Wissenschaft Im 19. Jahrhundert: Eine Rede Zur Jahrhundertwende, Gehalten Am 9. Januar 1900*, 8.
[770] Borje Uvnas, "The Rise of Physiology During the Nineteenth Century," in *Science Technology and Society in the Time of Alfred Nobel*, ed. Carl Bernhard, Elisabeth Crawford, and Per Sorbom (New York: Pergamon, 1982), 145; Peter Watson, *The German Genius: Europe's Third Renaissance, the Second Scientific Revolution, and the Twentieth Century* (New York: Harper, 2010), 353; Schiera, *Laboratorium Der Bürgerlichen Welt: Deutsche Wissenschaft Im 19. Jahrhundert*, 95.
[771] Jorg Zaun, "The Success of the German Instrument Industry and the Role of the Deutsche Gesellschaft Für Mechanik Und Optik," in *Scientific Instruments and Museums*, ed. Maurice Dorikens (Turnhout: Brepols, 2002), 325; Peter Alter, translated by Angela Davies, *The Reluctant Patron: Science and the State in Britain, 1850-1920* (New York: Berg, 1987), 115.
[772] Hermann, "Wissenschaftspolitik Und Entwicklung Der Physik Im Deutschen Kaiserreich," 62.

other nations.[773] German medicine in general had reached a world renown such that as a result the German bourgeoisie felt itself elevated, as the powerful the world over sought out their nation's physicians, while medical students from the leading nations came to learn at the German clinics.[774]

Science was a zone in which much was at stake, with a central role for universities.[775] German university organization gained worldwide fame for its promotion of scholarship by around 1870, according to Andreas Daum.[776] August Wilhelm von Hofmann related in the late 1870s that "[w]hoever has a German educational institution to thank for an advanced education, whoever has taught, if only for a short time, at such an institution, for him remains for life a deep nostalgia for the intellectual high plateau of a German university...The cord that surrounds and binds all members of the [German] university is the pursuit of truth...'[777] And, he said, "[t]he German universities are the glorious heart of our [German] cultural life.[778] American zoologist Charles Minot, who studied in the late nineteenth century at the German universities in Leipzig and Würzburg, was one of the German universities' enthusiasts:

> These universities are not, like our 'colleges', simply higher schools, but centers of great intellectual activity. In that research is given the highest place in their organization, the effort succeeds there to subordinate all else to research. Their rigorous enactment of research makes it possible for the German universities to be the homestead (*Heimat*) of science.[779]

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[773] Weindling, "Bourgeois Values, Doctors and the State: The Professionalization of Medicine in Germany 1848-1933," 216.
[774] Schnabel, *Deutsche Geschichte Im Neunzehnten Jahrhundert -- Erfahrungswissenschaften Und Technik*, 224; Hagner, "Scientific Medicine," 72-73.
[775] Birt, *Deutsche Wissenschaft Im 19. Jahrhundert: Eine Rede Zur Jahrhundertwende, Gehalten Am 9. Januar 1900*, 8.
[776] Andreas Daum, "*Wissenschaft* and Knowledge," in *Germany 1800-1870*, ed. Jonathan Sperber (New York: Oxford University Press, 2004), 137-38. Olson, *Science and Scientism in Nineteenth-Century Europe*, 116.
[777] Volhard and Fischer, *August Wilhelm Von Hofmann: Ein Lebensbild Im Auftrage Der Deutschen Chemischen Gesellschaft*, 134-35.
[778] Ibid., 138.
[779] Paul Glees, "Charles Sedgwick Minot 1852-1914," in *Geschichte Der Mikroskopie: Leben Und Werk Grosser Forscher -- Biologie*, ed. Hugo Freund and Alexander Berg (Frankfurt: Umschau Verlag, 1963), 264.

It was on the behalf of science and medicine that, as the philosopher and educator Friedrich Paulsen highlighted in 1902, university funding had reached incredibly high levels.[780] William Coleman conjectures that "[t]he German universities were perhaps the most distinctive intellectual institutions of the nineteenth century. Their impact on all realms of learning was great and, on the sciences...overwhelming."[781]

The state administration of the Empire was, unsurprisingly, intermittently willing to intervene on science's behalf, especially where the consequences were likely to have a bearing on the Empire's international status. For example, von Behring's achievements with anti-diphtheria serum were recognized by high Imperial German officials by their attendance at the opening of a serum-production facility under the commercial chemical firm of Hoechst.[782] When Behring threatened to go into Russian service if he was not granted a professorship at the university of his choice in Marburg, the normal university protocol was overridden by the Ministry of Educational, Religious and Medical Affairs to meet his request because of Behring's importance to Germany's scientific reputation.[783] Government agencies relating to science were created on national (imperial) lines, for example the Imperial Health Office in 1876, from which spun off the Biological Imperial Institute for Agricultural and Forest Economics in 1905.[784] The heightened association of science and technology with the nation registered in newly-founded so-called *national* museums for *contemporary* technology: the Imperial Postal Museum of 1872, the Design and Transport Museum of 1905, and the Oceanography Museum of 1905, all in Berlin.

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[780] Schieder, "Kultur, Wissenschaft Und Wissenschaftspolitik Im Deutschen Kaiserreich," 55.
[781] William Coleman, *Biology in the Nineteenth Century: Problems of Form, Function, and Transformation* (New York: Wiley, 1971), 4.
[782] Derek S. Linton, *Emil Von Behring: Infectious Disease, Immunology, Serum Therapy* (Philadelphia: American Philosophical Society, 2005), 179.
[783] Ibid., 194.
[784] Christian Hünemörder and Irmtraut Scheele, "Das Berufsbild Des Biologen Im Zeiten Deutschen Kaiserreich-Anspruch Und Wirklichkeit," in *Medizin, Naturwissenschaft, Technik Und Das Zweite Kaiserreich*, ed. Gunter Mann and Rolf Winau (Göttingen: Vandenhoeck & Ruprecht, 1977), 140.

With state and industry support and wide public backing and interest, during the German Empire there were unprecedented conditions for the flourishing of science. In addition to the state or state-and-industry ventures, industry, particularly electro- and chemical-based industry, continued in the successive decades of the German Empire to apply science more heavily in-house.

THE ROLE OF GERMAN SCIENCE IN FRAMING A NATIONAL IDENTITY

Generally, among the advanced nations, by about the middle of the nineteenth century, a linkage between scientific prowess and nationhood was unremarkable. There was a competitive rhetoric, with winners and losers.[785] Nations relied on the activities of science and engineering as proofs that one's own nation was capable of generating favorable living conditions, that it was up-to-date, and that it was on a par with the economies and militaries elsewhere.[786]

In the German lands during much of the nineteenth century even before the achievement in 1871 of unification, there was a perceived connection between the nation-to-be and the strong German science.[787] Speaking of the 1840s through the 1880s, Jutta Kolkenbrock-Netz writes that

[785] Ludmilla Jordanova, "Science and National Identity," in *Sciences Et Langues En Europe*, ed. Roger Chartier and Pietro Corsi (Paris: Ecole des hautes études en sciences sociales, 1996), 216.
[786] Harrison and Johnson, "Introduction: Science and National Identity," 8.
[787] Faidra Papanelopoulou, Agustí Nieto-Galan, and Enrique Perdiguero, *Popularizing Science and Technology in the European Periphery, 1800-2000* (Burlington, VT: Ashgate, 2009); Daniela Feistauer, *Christian Gottfried Nees Von Esenbeck: Die Bedeutung Der Botanik Als Naturwissenschaft in Der Ersten Hälfte Des 19. Jahrhunderts* (Halle: Deutsche Akademie der Naturforscher Leopoldina, 2006); Mitchell G. Ash and Jan Surman, *The Nationalization of Scientific Knowledge in the Habsburg Empire, 1848-1918* (Basingstoke, Hampshire: Palgrave Macmillan, 2012).

there was an "incorporation of the natural sciences in the national historical myth."[788] Historian Myles Jackson holds that there was a linkage between the achievement of German unification and the gestation of the world's most outstanding scientific corps.[789] Armin Hermann, historian of physics, writes about the German nation after 1871 that throughout the population there was esteem for science, associated with a belief in progress.[790] There was great German pride in the renown that scientific findings, which played an increasingly bigger role in the international competition for prestige, bestowed on their nation.[791] A tight connection between scientific mentality and the German nationality was suggested in 1878 by the chief organizer August von Hofmann as he reflected on German participation at the London Exhibition of Scientific Apparatus of 1876, detailed below: "How eagerly time and strength are offered in our Fatherland, when there's something relating to the support of science."[792] R. Steven Turner depicts a conglomerate, including one of *Wissenschaft* [learning], of German national myths in terms of which the profound desire of the Germans to attain national unity and personality was embodied.[793]

The connections between science and the national movement in the German lands reach back almost to the start of the nineteenth century. In a speech in 1809, responding to the Napoleonic duress, the physician and naturalist Lorenz Oken had called for the Germans to strengthen their *Bildung* through the cultivation of the natural sciences, a strategy he designated

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[788] Kolkenbrock-Netz, "Wissenschaft Als Nationaler Mythos: Anmerkung Zur Haeckel-Virchow-Kontroverse Auf Der 50. Jahresversammlung Deutscher Naturforscher Und Arzte in München (1877)," 225.
[789] Jackson, *Spectrum of Belief: Joseph Von Fraunhofer and the Craft of Precision Mechanics*.
[790] Hermann, "Wissenschaftspolitik Und Entwicklung Der Physik Im Deutschen Kaiserreich," 57.
[791] Hans Schleier, "Neue Ansatze Der Kulturgeschichte Zwischen 1830 Und 1900. Zivilisationsgeschichte Und Naturgesetze. Darwinismus Und Kulturbiologismus," in *Historisierung Und Gesllschaftlicher Wandel in Deutschland Im 19. Jahrhundert*, ed. Ulrich Muhlack, Christian Mehr, and Dagmar Stegmüller (Berlin: Akademie-Verlag, 2003), 20; Hermann, "Wissenschaftspolitik Und Entwicklung Der Physik Im Deutschen Kaiserreich," 63.
[792] Hofmann, "Vorwort," ix.
[793] Turner, "Commentary," 297.

as successfully adopted by other nations that were stronger than the German lands. Alexander von Humboldt followed with a proposal, not taken up for the time being, for a periodic gathering of German scientists. In 1822, Oken then successfully called forth an assembly of German scientists and medical practitioners, which was open to all and would meet annually at varying German-speaking locations, the first such anywhere. In 1828, serving as the head of that year's meeting, Alexander von Humboldt spoke of the meetings collectively as a site at which the contributions of German science were effectively promoted.[794] Heinrich Wilhelm Dove claimed in 1869 that Oken, in instituting the meetings of the German Natural Scientists and Physicians, increased "[t]he sense, that all those who speak a common tongue constitute an integral people."[795]

Already with the founding of the meetings of Scientists and Physicians, the notion of a "German science" and "German work" especially in contradistinction to that of the French was in play.[796] But more than that, the meetings already by 1830 evoked among their participants a subtext, solidifying the sense of the importance of moving from the current position of diverse German states towards a single Germany.[797] In the 1840s, Oken referred to the importance of science bearing a German stamp.[798] Twenty-five years after his founding of the meetings, Oken refers to them in a letter as "the spiritual symbol of the German people's unity", which might

[794] Jackson, *Harmonious Triads: Physicists, Musicians and Instrument Makers in Nineteenth-Century Germany*, 45-46.
[795] Heinrich Wilhelm Dove, *Gedächtnissrede Auf Alexander Von Humboldt: Gehalten in Der Öffentlichen Sitzung Der Königl. Preussischen Akademie Der Wissenschaften Zu Berlin Am 1. Juli, Dem Leibnitztage Des Jahres 1869* (Berlin: Dümmler, 1869), 4-5. M. J. Schleiden, *Geschichte Der Botanik in Jena* (Leipzig: W. Engelmann, 1859).
[796] Schnabel, *Deutsche Geschichte Im Neunzehnten Jahrhundert -- Erfahrungswissenschaften Und Technik*, 196.
[797] Jackson, *Harmonious Triads: Physicists, Musicians and Instrument Makers in Nineteenth-Century Germany*, 50.
[798] See the treatment of science and collective identity in Ludmilla Jordanova, "Science and Nationhood: Cultures of Imagined Communities " in *Imagining Nations*, ed. Geoffrey Cubitt (Manchester: Manchester University Press, 1998); Ralph Jessen and Jakob Vogel, eds., *Wissenschaft Und Nation in Der Europäischen Geschichte* (Frankfurt am Main: Campus Verlag, 2002).

serve as a template for unification in other areas of German life, chief among them the political realm.[799]

Rudolf Virchow, physician, student of archaeology, and prominent speaker at the meetings of Scientists and Physicians from the 1860s, whose views on the importance of science for the formation of a unified German nation are characterized below, looked back to the founding of the meetings in 1822 as the first of all the manifestations of the working together of the Germans for common purposes.[800] Heinrich Wilhelm Dove in a hundredth birthdate anniversary speech commemorating Alexander von Humboldt in 1869 also accorded to Oken a great significance in the formation of the feeling of unity among Germans.

As David Cahan writes, before German unification, another prominent German scientist, Hermann von Helmholtz, attributed to science the capacity to bring individuals together and to secure their devotion to the nation-state they belonged to.[801] By 1862, Helmholtz emphasized that natural sciences and their technical application were behind the strength of nations. It was indispensible for a nation desiring autonomy and influence to cultivate them.[802] Helmholtz said, "[n]o nation which wants to remain independent and influential can fall behind in the task [of developing the knowledge of the natural sciences and their technical applications]."[803] In 1869, at that year's meeting of Scientists and Physicians, he credited the Germans, a "hard-working,

[799] Kolkenbrock-Netz, "Wissenschaft Als Nationaler Mythos: Anmerkung Zur Haeckel-Virchow-Kontroverse Auf Der 50. Jahresversammlung Deutscher Naturforscher Und Arzte in München (1877)," 215, 17.
[800] Virchow, *Ueber Die Nationale Entwickelung Und Bedeutung Der Naturwissenschaften: Rede Gehalten in Der Zweiten Allgemeinen Sitzung Der Versammlung Deutscher Naturforscher Und Aerzte Zu Hannover Am 20. September 1865*, 18.
[801] David Cahan, "Introduction: Helmholtz at the Borders of Science," in *Hermann Von Helmholtz and the Foundations of Nineteenth-Century Science*, ed. David Cahan (Berkeley: University of California Press, 1993), 12.
[802] Timothy Lenoir, translated by Horst Brühmann, *Politik Im Tempel Der Wissenschaft: Forschung Und Machtausübung Im Deutschen Kaiserreich* (Frankfurt: Campus Verlag, 1992), 42.
[803] Olson, *Science and Scientism in Nineteenth-Century Europe*, 141.

temperate, strictly moral people", with greater capacity to "look truth full in the face" (here, meaning scientific truth in particular) than the people elsewhere.[804] Seconding Helmholtz's positions, Ernst Abbe, famed optical scientist of the late nineteenth century, was of the opinion that "pride in the success of our [past] fellow citizens [such as the early nineteenth century optical scientist Joseph von Fraunhofer]…is an undoubtedly good and worthwhile form of national pride and national ambition…"[805]

With Rudolf Virchow's example, we have the view on the connection of learning (or science) and nation most extensively articulated by a German scientist. For Virchow, the Germans were irrevocably becoming a developed nation bearing the imprint of science.[806] Before unification, he imagined a German nation brought together in a significant degree by its scientific pursuits. In 1865 Virchow pronounced, "[w]e owe our capability in natural inquiry to the circumstances, that in part our predecessors, in part ourselves, have attached ourselves ever moreso to the national life" and pointed to "the importance that natural science has for the national being."[807]

Virchow judged that the science in which Germany was forging ahead was closely associated with a Protestant-framed national German identity. He held that the (north) German manner of thought, critical and self-reliant, had persisted through the centuries since the Reformation and was the epitome of the scientific approach that was pushing civilization to ever higher advances. Virchow wished to call attention to how much the German people have

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[804] Marc Schalenberg, "Die Nation Als Strategischer Einsatz," in *Wissenschaft Und Nation in Der Europaischen Geschichte*, ed. Ralph Jessen and Jakob Vogel (Frankfurt am Main: Campus, 2002), 49.
[805] citation in Jackson, *Spectrum of Belief: Joseph Von Fraunhofer and the Craft of Precision Mechanics*, 191.
[806] Goschler, "Deutsche Naturwissenschaft Und Naturwissenschaftliche Deutsche," 112.
[807] Virchow, *Ueber Die Nationale Entwickelung Und Bedeutung Der Naturwissenschaften: Rede Gehalten in Der Zweiten Allgemeinen Sitzung Der Versammlung Deutscher Naturforscher Und Aerzte Zu Hannover Am 20. September 1865*, 25, 18.

contributed to the natural sciences, and to the composition of general human culture. He felt justified to contest the adage that science was a republic of letters, putting, rather, a more national emphasis on it.[808] He maintained that German [evidently north, i.e. non-Austrian German] science, given its example by the Protestant Reformation, could be characterized as thinking free of outside authority.[809] He saw the Reformation as the period when German science began to be autonomous: post-Reformation, the science done in the majority-Protestant German lands acquired cultural-historical significance.[810]

German science's relevance for national identity, in Virchow's view, did not equally favor science practiced by all Germans. Rather, he pegged the prototype German as Protestant, linking religious identity to correct scientific attitude and achievement. Virchow limited the flowering of science in the German lands to the area north of the Alps, not to their south where Austria's Empire sat.[811] In science, Virchow contrasted France, motivated by its Revolution, as the opposite to Germany, adhering to Reform, asserting that now German sciences were in many cases superior to those of the French.[812] He pointed to a current German scientific analysis of society that "depends on no foreign land, and that…derives from fundamental study of German being and nature."[813] He declared that "[s]cience has become for us a religion."[814]

Disparagement by the German Protestant scientists of the negative role of Catholicism was

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[808] Ibid., 7.
[809] Ibid., 20.
[810] Ibid., 8.
[811] Ibid., 10.
[812] Goschler, "Deutsche Naturwissenschaft Und Naturwissenschaftliche Deutsche," 107. Virchow, *Ueber Die Nationale Entwickelung Und Bedeutung Der Naturwissenschaften: Rede Gehalten in Der Zweiten Allgemeinen Sitzung Der Versammlung Deutscher Naturforscher Und Aerzte Zu Hannover Am 20. September 1865*, 16.
[813] Virchow, *Ueber Die Nationale Entwickelung Und Bedeutung Der Naturwissenschaften: Rede Gehalten in Der Zweiten Allgemeinen Sitzung Der Versammlung Deutscher Naturforscher Und Aerzte Zu Hannover Am 20. September 1865*, 20.
[814] Kolkenbrock-Netz, "Wissenschaft Als Nationaler Mythos: Anmerkung Zur Haeckel-Virchow-Kontroverse Auf Der 50. Jahresversammlung Deutscher Naturforscher Und Arzte in München (1877)," 224.

nothing new. Already in the early 1840s a mainstream sentiment in Germany against Catholicism as an antithesis to the supposed stamp given by the nation to Protestantism was shored up by charges of Catholicism's perceived restraints on science. Emil du Bois-Reymond fulminated against the Italian states, which he maintained could be characterized as beset by "a wild and corrupt nobility, a cursed clergy, and a treacherously growling third estate," while his animus extended to other Catholic lands.[815] "A miserable regiment of parsons" bore responsibility for the fact that "Italy, Spain and Ireland have now been struck from the list of civilized countries and France has been brought to the edge of the abyss."[816] In the late 1850s, the famed botanist Matthias Schleiden in his Rectoral speech at the University of Jena endowed Protestantism with the credit for the "liveliness, freedom and power" that German science enjoyed in an earlier epoch. (Protestant) Germans "learned, of course, from [the texts of] the ancients, but also learned from them to approach Nature herself, the actual source" of natural knowledge.[817] Some Germans at the end of the century also went on record to discredit Catholicism. Physiologist Ludwig Büchner in 1900 touted "the victory of the Reformation and with it the rebirth of human intellect from the shackles of narrow-minded dogmatism and confinement by the [Catholic] church."[818]

For Virchow, "a true unity" of the German nation was desirable, based on the adoption of the scientific method by the nation as a whole, and applied to its thought and its moral actions.[819]

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[815] quoted in Finkelstein, *Emil Du Bois-Reymond: Neuroscience, Self, and Society in Nineteenth-Century Germany*, 58.
[816] quoted in Ibid., 141.
[817]Schleiden, *Geschichte Der Botanik in Jena*, 17-18.
[818] Ludwig Andrew Büchner, *Am Sterbelager Des Jahrhunderts: Blicke Eines Freien Denkers Aus Der Zeit in Die Zeit* (Giessen: Emil Roth, 1900), 8.
[819] Kolkenbrock-Netz, "Wissenschaft Als Nationaler Mythos: Anmerkung Zur Haeckel-Virchow-Kontroverse Auf Der 50. Jahresversammlung Deutscher Naturforscher Und Arzte in München (1877)," 224.

Science would be the great unifier among all the Germans, hopefully, but this capacity would depend on their adopting "a Protestant mind" at least in their scientific practice.[820] The attempt to define German-ness as fundamentally Protestant may have instilled a more robust collective feeling among the German Protestants, but it could not fully satisfy those German scientists who were Catholics or (a smaller absolute number) Jews.

In the course of the nineteenth century, various figures were insistent that the German national style of performing science was distinctive. Honesty and honor in science were held to be unsullied and a mark of the larger German character. As Justus von Liebig had said before the Bavarian Academy of Sciences in 1871,

> [i]n the specific character of the German, his fluency in languages, his understanding for the alien nation, his cultural-historical perspective, lies the basis for his being upright to other peoples, often extending to injustice towards himself, and so we don't misconstrue what we owe to the great philosophers, mathematicians and scientists of France, which have been our instructors and our models in so many fields.[821]

Astrophysicist Karl Zöllner in the same year felt that

> Germany is uniquely accredited to be the locus of [an upcoming epoch of deductive knowledge of the world, whose equal in beauty, command and richness of harmony has never before been seen]; for only the German spirit conceals within its depths that depot of the deductive exigencies and capabilities that are necessary for the successful mastery of the inductive materials stored up through the exact sciences.[822]

Du Bois-Reymond made a claim of "detachedness and historical fairness…[corresponding to] the German character in [its prosecution of] learning."[823] In 1878 he offered a related analysis of

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[820] For the academic Theodor Birt, lecturing in 1900, this assimilation by Germans of the scientific approach into all facets of life had been achieved. Birt, *Deutsche Wissenschaft Im 19. Jahrhundert: Eine Rede Zur Jahrhundertwende, Gehalten Am 9. Januar 1900*, 16.
[821] Jakob Volhard, *Justus Von Liebig*, 2 vols., vol. 2 (Leipzig: Barth, 1909), 421.
[822] Johann Karl Friedrich Zöllner, *Uber Die Natur Der Cometen: Beiträge Zur Geschichte Und Theorie Der Erkenntnis* (Leipzig: W. Engelmann, 1872), lxxvii, quoted in Meinel, *Karl Friedrich Zöllner Und Die Wissenschaftskultur Der Gründerzeit: Eine Fallstudie Zur Genese Konservativer Zivilisationskritik*, 26.
[823] Emil Du Bois-Reymond, Estelle DuBois-Reymond, and Julius Rosenthal, *Reden Mit Einer Gedächtnisrede Von Julius Rosenthal*, 2 ed., 2 vols., vol. 1 (Leipzig: Veit, 1912), 436.

the superiority in science of German "conscious cosmopolitanism", with its aspiration for the universal, as against what he called the French and British refusal to see beyond their own nations' scientific output, resulting in senseless rediscovery or inaccurate attributions.[824] The 1893 German catalogue for the Chicago World's Fair maintained that "the German chemical industry['s] thriving condition…is mainly due to the fact that in Germany pure scientific chemical research has been carried on…with especial zeal."[825]

Theodor Birt maintained in 1900 that the German scientists worked at the level of the small detail to build up the knowledge of grand principles.[826] Wilhelm Ostwald was mirroring a generally held self-assessment among the late nineteenth century Germans when he said that "the German [chemist] reflects [unlike the practically-disposed English] on general foundations, which he has made his own, and soon finds his way."[827] Karl von Sudhoff boasted in 1906 of the "world-accepting German tendency to take up the creative products and productive ideas of the other nations and, incorporating them, develop them further, for themselves and their neighbors, for the use of the well-disposed and the hostile, in the peaceful competition of the nations of the world."[828] In 1911, one of the contributors to the celebratory volume *Deutschland als Weltmacht* claimed for the German nation the "deepest philosophical insights in all cultural and natural sciences" arising from a spirit "in equal measure devout and free."[829] Historian Eduard Meyer in

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[824] Finkelstein, *Emil Du Bois-Reymond: Neuroscience, Self, and Society in Nineteenth-Century Germany*, 219.
[825] Witt, ed. *Columbische Weltausstellung in Chicago: Amtlicher Katalog Der Ausstellung Des Deutschen Reiches*, 146.
[826] Birt, *Deutsche Wissenschaft Im 19. Jahrhundert: Eine Rede Zur Jahrhundertwende, Gehalten Am 9. Januar 1900*, 8.
[827] Wilhelm Ostwald, "Die Wissenschaftliche Elektrochemie Der Gegenwart Und Die Technische Der Zukunft," in *Abhandlungen Und Vorträge Allgemeinen Inhaltes (1887-1903)*, ed. Wilhelm Ostwald (Leipzig: Veit, 1904), 134.
[828] Sudhoff, "Zur Grundsteinlegung Des Deutschen Museums Von Meisterwerken Der Naturwissenschaft Und Technik Am 13. Nov. 1906," 2251.
[829] Paul Lorentz, "Die Deutsche Wissenschaft," in *Deutschland Als Weltmacht: Vierzig Jahre Deutsches Reich, Unter Mitarbeit Einer Grossen Anzahl Berufener Deutscher Gelehrter, Offiziere Und Fachmänner*, ed. Kaiser-Wilhelm-Dank and Verein-der-Soldatenfreunde (Berlin: Wohlfahrtsgesellschaft m.b.h., 1911), 461.

1917 also accentuated the freedom grown into by the German students at the upper secondary and university levels, and the depth of the German mental life and the German quest for inner authenticity [*Wahrhaftigkeit*].[830] Germans found it encouraging to see truthfulness, dedication to the foundations in science, and sobriety all as inherently German traits: thus did the German practitioners lead in science, and science give representation to the most authentic traits of the German people and nation.

The German scientists during the latter period of the Empire increasingly saw their nation's scientific achievements as German in character and opposed to those made in other nations. Felix Klein, head of the German universities exhibit, wrote in 1893 for an official publication for the Chicago World's Fair: "through the French Revolution, here and elsewhere a division between the nations, a certain stamp of national specificity [in scientific activity] took hold. Scientific ideas themselves retained international validity...but their cultivation and development proceeded on national grounds."[831] The implication was that the German character was consistent with the high standing its science had attained during the course of the century.

Timothy Lenoir has effectively argued that there was an "attitude widespread among German industrialists, academics, and state ministers that leadership in the production of scientific knowledge was essential to the economic and political strength of the *Kaiserreich*."[832] Lothar Burchardt maintains that "[m]ore and more the conviction took hold among entrepreneurs

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[830] Eduard Meyer, *Die Aufgaben Der Höheren Schulen Und Die Gestaltung Des Geschichtsunterrichts* (Leipzig: B. G. Teubner, 1918), 85.
[831] Felix Klein, "Mathematik," in *Die Deutschen Universitäten: Für Die Universitätsausstellung in Chicago 1893, Unter Mitwirkung Zahlreicher Universitätslehrer*, ed. Wilhelm Hector Lexis and Richard Albrecht (Berlin: Asher, 1893), 7.
[832] Timothy Lenoir, *Instituting Science: The Cultural Production of Scientific Disciplines* (Stanford: Stanford University Press, 1997), 97.

that (natural-)scientific progress was a decided precondition for the retention of Germany's economic position against other nations."[833]A 1905 memorandum by chemist Emil Fischer in favor of a central Imperial institute of chemistry posited that scientific intensity and the capacity to put it to economic use increasingly determined a nation's intellectual and material standing.[834]

Arleen Tuchman, writing of the German scientific practitioners, subscribes to a connection between the bourgeoisie and the scientific and general transformation of life in Germany: "the studies of the Imperial period demonstrate that a significant number of elite academic scientists (who made up an important component of the German bourgeoisie) embraced, and indeed were partly responsible for, the social, economic, and cultural changes that transformed their country in the post-unification [post-1871] period."[835]

SCIENCE INCREASINGLY CLAIMED AS A CULTURAL ASSET

Science was a key element of society and, increasingly, an element in cultural orientation during the second half of the nineteenth century.[836] As Denise Phillips points out, the word *Naturwissenschaft* (natural science) already "communicated fervor and inspired loyalty" beginning about 1770, and by 1850 there was a cultural resonance of the word that it had largely lacked before 1770; it "became invested with…emotional intensity."[837] As contemporary science increasingly carried cultural credentials, the role of its past and present in the national identity correspondingly rose. This push further secured the linkage of German science and the national

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[833] Lothar Burchardt, *Wissenschaftspolitik Im Wilhelminischen Deutschland: Vorgeschichte, Grundung Und Aufbau Der Kaiser-Wilhelm-Gesellschaft Zur Förderung Der Wissenschaften* (Göttingen: Vandenhoeck und Ruprecht, 1975), 135.
[834] Ibid.
[835] Arleen Tuchman, "Institutions and Disciplines: Recent Work in the History of German Science," *The Journal of Modern History* 69, no. 2 (1997): 318-19.
[836] Russell McCormmach, "On Academic Scientists in Wilhelmian Germany," *Daedalus* 103, no. 3 (1974): 158.
[837] Phillips, *Acolytes of Nature: Defining Natural Science in Germany, 1770-1850*, 30.

identity, for culture was at the heart of what constituted a people. During the Empire, the German middle class was left to pursue a strong *cultural* agenda as it was largely edged out of a political influence on state administration, and was highly active in industry.[838] The German scientific community also, along with other national scientific communities, desired to be taken seriously in the cultural realm. Within the bourgeoisie, and specifically within its *Bildungsbürgertum* element, those dedicated to science sought to match the social stature accorded to their fellows who excelled in the humanities and fine arts.

The entry of the history of sciences into a number of the display sites in this period both supported and reflected the emergence of a new understanding of the sciences and technology as a part of culture as a whole. Brigitte Schroder-Gudehus, long an investigator of the history of science and technology museums, writes: "It is precisely this gradual recognition of science and technology as integral parts of general culture, and thus as belonging in museums… which make the political history of [science and technology] museums so interesting."[839] This applies equally well to temporary historical scientific displays. Temporary displays and permanent exhibitions could help promote the place of science vis-à-vis the other cultural leadership claimants like religion and the humanities. As the German Empire was first founded, science was making a bid to confirm itself as the nation's primary player socially, culturally and intellectually.[840] Engineer-entrepreneur Wilhelm von Siemens, particularly in his 1886 talk before the national body of German scientists, alluded to

> the powerful transforming influence, which science and the arts combined have exerted on the spiritual and material development of our time…Periods of development which in

[838] Wehler, "Wie Bürgerlich War Das Deutsche Kaiserreich?," 267.
[839] Brigitte Schroeder-Gudehus, Eckhard Bolenz, and Anne Rasmussen, *Industrial Society and Its Museums, 1890-1990: Social Aspirations and Cultural Politics* (Langhorne, PA: Harwood Academic Publishers, 1993), 2.
[840] Peter Kjaergaard, "Within the Bounds of Science: Redirecting Controversies to Nature," in *Culture and Science in the Nineteenth Century Media*, ed. Louise Henson (Aldershot: Ashgate, 2004), 212.

> earlier times were only traversed in centuries, which then at the beginning of our century needed tens of years, are now completed in years…[T]hanks to...the present extensive spread of modern culture the scientific and technical acquisitions of mankind cannot again be lost.[841]

In 1900 biologist Oscar Hertwig commented on

> our cultural period with its exceptionally heightened scientific interests, its perfected organization of scholarly work, its numerous different scientific institutes, its facilitated and accelerated exchange of ideas through journals and also through newspapers which, when a new goal is laid out and the way to its fulfillment—the scientific method—is found, then everywhere workers start up in a feverish activity, like in no earlier time."[842]

In 1903, Oskar von Miller, leading spirit behind the Deutsches Museum of science and technology, communicated to his potential supporters that the influence of industry and the technical sciences "on all domains of culture comes more and more into currency."[843] In 1906, physicist Leo Graetz looked at the new Deutsches Museum as a site where the doyens of science past and present and their achievements would get raised to the highest level of societal recognition as cultural assets.[844]

Ernst Gerland spoke at a festival for Wilhelm II in 1910:

> With happy pride we pay tribute to the height of culture to which...[our German people] has risen, risen in competition with other nations...The rapidity with which the current newest advances crowd out the [merely] new strikes us as amazing...If we compare this progress with what earlier centuries, even millenia, have shown, it is difficult to take in what [a line of advances] the newspapers now daily report… There can be no doubt, that we owe this elevation of our cultural credentials to the rapid development of the exact natural sciences supported most efficaciously by mathematics...[845]

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[841] Siemens, "The Age of Natural Science," 511-12.
[842] Oscar Hertwig, *Die Entwicklung Der Biologie Im 19. Jahrhundert: Vortrag Auf Der Versammlung Deutscher Naturforscher Zu Aachen Am 17. September 1900 Mit Einem Zusatz Über Den Gegenwärtigen Stand Des Darwinismus*, 2. erweiterte ed. (Jena: G. Fisher, 1908), 8.
[843] Stange, *Das Deutsche Museum Von Meisterwerken Der Naturwissenschaft Und Technik in München: Historische Skizze*, 1.
[844] Graetz, "Die Bedeutung Und Die Aufgabe Des Deutschen Museums," 291.
[845] Gerland, "Über Die Anregungen, Die Der Bergbau Im Laufe Der Kulturgeschichte Der Naturwissenschaft Und Technik Hat Angedeihen Lassen," 301-02.

In 1911, Julius Kollmann wrote that "[t]he culture of our time stands in tight connection with the improvement of transport and the development of pure and applied natural science. It is not any more the sole possession of select classes of our people, but a general property of the nation..."[846] Walther von Dyck, co-director of the Deutsches Museum, emphasized not only present but past science as a marker of German culture. Stating that the Deutsches Museum projected a series of publications focusing on how science has contributed to culture, he wrote

> In recent decades the sense for historical consideration of natural science and technology has substantially risen, as a series of significant publications of very recent date shows. Now it becomes more desirable to evaluate the position of natural science and technology within our whole cultural development….[with humankind] producing great, unifying ideas that put our natural scientific knowledge on a new basis, as modern technology uses technical scientific research.[847]

Conrad Matschoss, long associated with the Deutsches Museum, the scientific site with the greatest number of historical exemplars during the German Empire, spoke to his Society of German Engineers in 1917 of how the museum "points out the great inner mental worth involved with technological work."[848] His comment highlights how the performance and efficacy of work—the eminently bourgeois virtue—in science were being raised to a transcendent cultural value that could be appraised in both the past and present.

Display of the history of science contributed in turn to raising the cultural profile of science. As Martin Weiss observes,

"…in these new museums [of science and technology, of which the Deutsches Museum

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[846] Julius Kollmann, "Der Triumphzug Der Technischen Wissenschaften," in *Deutschland Als Weltmacht: Vierzig Jahre Deutsches Reich, Unter Mitarbeit Einer Grossen Anzahl Berufener Deutscher Gelehrter, Offiziere Und Fachmänner*, ed. Kaiser-Wilhelm-Dank and Verein-der-Soldatenfreunde (Berlin: Wohlfahrtsgesellschaft m.b.h., 1911), 462.
[847] Dyck, *Georg Von Reichenbach: Lebensbeschreibungen Und Urkunden*, ii [no actual pagination].
[848] Ulrich Menzel, "Die Musealisierung Des Technischen. Die Gründung Des „Deutschen Museums Von Meisterwerken Der Naturwissenschaft Und Technik" in München" (Technische Universität Carolo-Wilhelmina zu Braunschweig, 2001), 87.

> was "one of the first and most influential"], products of science and technology were actively construed as cultural artefacts by constructing a museum where they could be put on display, with the explicit aim of enhancing the status of science and technology as a whole, and shoring up their credentials as academic disciplines."[849]

Popularizers proclaimed changes in the manner of perception, ideas, values and convictions, in short, in thinking, arising from the impact of science.[850] The rapid changes themselves became emblematic of modernity.[851] The public was increasingly during the German Empire in a position to receive and follow the contemporary science. More of the population, with advancing levels of education, was capable of informing themselves as to scientific developments. Such factors as urbanization, reduced work hours from the 1870s, paid vacation starting in the 1880s, and generally increased prosperity led to substantially larger numbers of people being involved in some scientific pastimes or interests than even during earlier decades of the century.[852]

The German general periodicals imprinted the public with the importance of science as it penetrated to all the facets of life during the century. *Grenzboten* featured reports on the natural sciences that gave educated readers a sense of their expansion and vigor and helped them

[849] Weiss, "'Monuments of Science': How the Teyler Museum's Instrument Collection Became Historical," 212.
[850] Schwarz, *Der Schlüssel Zur Modernen Welt: Wissenschaftspopularisierung in Grossbritannien Und Deutschland Im Übergang Zur Moderne (Ca. 1870-1914)*, 191.
[851] Ibid., 18.
[852] Klaus-Harro Tiemann, "Wilhelm Julius Foerster Und Die Vereinigung Von Freunden Der Astronomie Und Kosmischen Physik (1891-1914)," in *3 X Foerster: Beiträge Zu Leben Und Werk Von Wilhelm Foerster, Friedrich Wilhelm Foerster Und Karl Foerster*, ed. Mathias Iven (Milo: Schibri Verlag, 1995).

understand the ramifications for politics and culture.[853] The mass-readership *Gartenlaube* and its conservative-Christian knock-off *Daheim* celebrated science and discovery with both pride and, at times, hubris.[854] Articles in *Gartenlaube* fostering a linkage between the German nation and the most recent inventions sustained the belief that the nation was able to compete internationally and that its future was promising.[855] The nation's prosperity, in these accounts, was joined with its ability to modernize, which included its participation in science and technology alongside increasing secularization, literacy and dispersion of knowledge, and movement of people.[856] The German schools provided some degree of science teaching. An English study of the 1860s had found that "[p]lenty of time remains in German schools for the teaching of science which forms so important a part of education" there.[857] In 1868 the English poet and educator Matthew Arnold, referring to German higher education, reported that science was a principal element of its success.[858] Arnold noted that this strength was founded on the provision of science in the German primary and secondary schools "…which gives the German a starting point in life so

[853] Sheehan, *German History, 1770-1866*, 814.
[854] Blackbourn, *The Long Nineteenth Century: A History of Germany, 1780-1918*, 282; Belgum, "A Nation for the Masses: Production of German Identity in the Late-Nineteenth-Century Popular Press," 176 footnote 1; *Popularizing the Nation: Audience, Representation, and the Production of Identity in Die Gartenlaube, 1853-1900*, 55. For testimony from that time regarding Gartenlaube's content, see Wilhelm Ostwald, Fritz Scholz, and Robert Jack, eds., *Wilhelm Ostwald: The Autobiography* (Cham: Springer, 2017 (originally published in German as *Lebenslinie* in 1927)), 13.
[855] Belgum, *Popularizing the Nation: Audience, Representation, and the Production of Identity in Die Gartenlaube, 1853-1900*, 56-57, 66.
[856] Schwarz, *Der Schlüssel Zur Modernen Welt: Wissenschaftspopularisierung in Grossbritannien Und Deutschland Im Übergang Zur Moderne (Ca. 1870-1914)*, 18. See David M. Knight, *The Making of Modern Science: Science, Technology, Medicine and Modernity 1789-1914* (Cambridge, U. K.: Polity, 2009), 195 for a similar, if less developed, conclusion linking science with modernity.
[857] John Ziman, "Social Responsibility in Victorian Science," in *Science, Technology and Society in the Time of Alfred Nobel: Symposium; Björkborn, 17-22 August 1981*, ed. Carl Gustaf Bernhard, Elisabeth Crawford, and Per Sorbom (Oxford: Pergamon Press, 1982), 26.
[858] A.G. Keller, "Discussion," in *Science, Technology and Society in the Time of Alfred Nobel*, ed. Carl Bernhard, Elisabeth Crawford, and Per Sorbom (New York: Pergamon, 1982), 45.

very much superior to that which the average Englishman has, even when educated at our public schools and universities."[859]

Certain German lands, and then the German Empire, were lucky in having monarchs alive to the importance of science. Already in 1857, after Helmholtz had presented an account of his investigations at the Scientists and Physicians meeting in Bonn, the King of Bavaria was sufficiently excited to contact him in readiness "to apply a considerable annual sum to the very objects I proposed to the Congress, i.e. to endow such scientific undertakings as exceed the powers of private persons, and asks my advice as to the expenditure."[860] Of the three emperors during the Empire, Wilhelm II, grandson of Wilhelm I, succeeding his father who had ruled only ninety-nine days before his untimely death from cancer, and reigning from 1888 to 1918, continued and amplified his grandfather's and father's enthusiasm for science. Under Wilhelm II, Germany sought to become a player on the world stage. To this end, Wilhelm devoted time and his personal funds for the advance of German science and learning. As one example, when the team of Robert Koch identified the cholera bacillus in India, Wilhelm, hailing the propaganda gain for Germany, personally met him and announced that he was to be granted 100,000 marks for his research.[861]

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[859] citation in Ziman, "Social Responsibility in Victorian Science," 26; Kathryn Olesko, "Introduction," *Osiris, 2nd series* 5 (1989): 12.
[860] Leo Koenigsberger, translated into English by Frances A. Welby, *Hermann Von Helmholtz* (Oxford: Clarendon Press, 1906), 162.
[861] Robert D. Morris, *The Blue Death: Disease, Disaster and the Water We Drink*, 1st ed. (New York: HarperCollins, 2007), 130.

THE GERMAN COMPETITIVENESS AND SUCCESS IN SCIENCE

German historian Hans Schimank notes that as science during the nineteenth century was increasingly pursued from a national standpoint, its potential ability to join different peoples together decreased.[862] In Angela Schwarz's view, as the competition among the European states intensified, less and less was the sheer progress of knowledge and of individual development brought forward as the justification for the support of science. Rather, science's bearing on any one's nation's international stature loomed as the primary basis for that science's legitimation.[863]

Schwarz specifies that nationalistic characteristics were increasingly present in the sciences especially from the eighteen sixties, though she maintains that an international element remained important.[864] The historian of international science Brigitte Schroder-Gudehus notes that with nations competing with one another in advancing scientific knowledge, in a way that included attributions of superiority and inferiority, those nations failing to keep pace scientifically were regarded as subject to a future decline.[865]

The national orientation that had marked science became representative of the sharpened contestation among nations more generally at the end of the century.[866] The Germans were prone to refer to and even contribute to their nation's superior scientific performance as a prime means of asserting their national power. The 1893 German catalogue of the Chicago World's Fair

[862] Hans Schimank, "Physik Und Chemie Im 19. Jahrhundert: Ihre Abkunft, Ihre Hilfsmittel Und Ihre Wandlungen," in *Naturwissenschaft, Technik Und Wirtschaft Im 19. Jahrhundert: Acht Gespräche Der Georg-Agricola-Gesellschaft Zur Förderung Der Geschichte Der Naturwissenschaften Und Der Technik. Teil 2.*, ed. Wilhelm Treue and Kurt Mauel (Göttingen: Vandenhoeck & Ruprecht, 1976), 372.
[863]Schwarz, *Der Schlüssel Zur Modernen Welt: Wissenschaftspopularisierung in Grossbritannien Und Deutschland Im Übergang Zur Moderne (Ca. 1870-1914)*, 145.
[864] Ibid., 66.
[865] Brigitte Schroeder-Gudehus, "Science, Technology and Foreign Policy," in *Science, Technology, and Society: A Cross-Disciplinary Perspective*, ed. Ina Spiegel-Rosing and Derek J. de Solla Price (Beverly Hills: Sage, 1977), 473.
[866] Schimank, "Physik Und Chemie Im 19. Jahrhundert: Ihre Abkunft, Ihre Hilfsmittel Und Ihre Wandlungen," 372.

boasted that "German machinery has in the course of time attained to such a height of excellence, that it has long been in a position to maintain a successful competition with the machinery of other countries in the markets of the world."[867] In 1900, Theodor Birt preened that "[t]he triumph of German science of this [19th] century is the triumph of German spirit above all foreign lands."[868] In 1907, at the meeting of Researchers and Physicians, one attendee from Dresden noted that "Germans are a proudly upwards striving people on the basis of our natural scientific knowledge."[869] A decade after the turn of the twentieth century, Adolf von Harnack expressed the competitiveness and pride that Germans felt in their achievements in science: "Our fatherland …[stands] at the pinnacle of all cultural nations in its scientific repute."[870] "Science, and with it strength of arms, are the two strong pillars of the greatness of Germany."[871]

Any and all tactical maneuvers to garner credit for German science, sometimes at the expense of validation of rival nations' science, sometimes seemed to be fair game. There were instances of nineteenth century claims for the German national identity of some earlier scientists whose origins were contested. Two examples of appropriations by Germans during the Empire of scientific heroes of controvertible nationality were found at the German displays of the history of science. One, already detailed above, was the small exhibition in Cologne exclusively devoted to Mercator, sixteenth century map-maker of seminal importance to the development of geography, which explicitly laid claim to Mercator as a German countryman, and made no reference to the Flemish side of his biography. The other was the Deutsches Museum's inclusion of Copernicus

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[867] Witt, ed. *Columbische Weltausstellung in Chicago: Amtlicher Katalog Der Ausstellung Des Deutschen Reiches*, 95.
[868] Birt, *Deutsche Wissenschaft Im 19. Jahrhundert: Eine Rede Zur Jahrhundertwende, Gehalten Am 9. Januar 1900*, 8.
[869] Wangerin, ed. *Verhandlungen Gesellschaft Deutscher Naturforscher Und Ärzte 79. Versammlung Zu Dresden 15.-21. September 1907 Medicinische Abtheilungen*, 12.
[870] Anonymous, *50 Jahre Kaiser-Wilhelm-Gesellschaft Und Max-Planck-Gesellschaft Zur Förderung Der Wissenschaften, 1911-1961: Beiträge Und Dokumente*, 84, 80.
[871] Ibid., 89.

in its Hall of Honor for scientific heroes (not finalized until 1925, but the initial proposal to include him there had been made in 1908 by the museum's number two director Walther von Dyck, and approved by the museum commission)—itself a repetition of the installation in a decorative ensemble at the 1828 Physicians and Scientists meeting in Berlin of Copernicus alongside other indisputably Germanic scientists of the past, and the inclusion in 1840 of Copernicus in the Walhalla monument at Donaustauf in celebration of German heroes.[872] Copernicus had been born in Thorn, a town which before his birth was fought over and taken into the Kingdom of Poland. Thorn was primarily German-speaking, but Copernicus also spoke Polish. There were thus grounds for considering him of either ethnicity/nationality.

The resistance to recognition of one's national opponents' scientific achievements amounted to a diminishing of those opponents' assertions of power.[873] Ascriptions belittling or challenging non-German science had begun already before the onset of the nineteenth century. The German resistance to French scientific advances were long manifested, particularly in the field of chemistry: the Germans, as Lavoisier in the years before the French Revolution enunciated his new oxygen combustion theory, clung fast to the doctrine of phlogiston, introduced originally by the German Stahl, to explain combustion. They regarded the French innovations with suspicion, claiming and, spurred by national rivalry believing, that despite French achievements in other sciences, the French nation was unlikely to spur any important chemical developments. Among the German chemists, those who did not support the teaching of phlogiston suffered reproof as the advocates of France. Until around 1793, the doctrine of phlogiston remained in place in German lands, particularly in those regions dominantly

[872] "Die Jahresversammlung Des Deutschen Museums," *Zeitchrift des Vereins deutscher Ingenieure* 52, no. 1 (1908): 32. Jackson, *Harmonious Triads: Physicists, Musicians and Instrument Makers in Nineteenth-Century Germany*, 63.
[873] Helge Kragh, *An Introduction to the Historiography of Science* (New York: Cambridge University Press, 1987).

Protestant, whose chemists maintained a nationalistic sense of commonality. In 1794 the German physicist G.C. Lichtenberg, viewing askance Lavoisier's ideas, was stern: "France is not the nation, from whom Germans are accustomed to expect lasting principles for the sciences. The brilliant and the short-lived are customary, which it previously and heretofore has counted on. You find such among this people from the least to the greatest…"[874] At exactly the same period, mathematician Abraham Kästner took umbrage at "the national carelessness of the French" and, similarly, mathematician Johann Hauff wrote that he had "not expect[ed] much from the mathematical physics produced by a Frenchman", referring to the engineer Lazare Carnot.[875]

The German scientists continued to rail against the presumption of the French scientists when the latter were still in the vanguard in the early decades of the nineteenth century. In 1829 Friedrich Wöhler complained that the French chemists read nothing that was not published in their country's own *Annales de chimie*.[876] Liebig, scornful that two French chemists had published results without including a description of their experimental procedures, uttered a familiar charge: "[o]ne hardly knows whether this behavior can be laid more to arrogance or vanity."[877] Modifying his charges as the scope and value of the *German* chemical research surged in the 1830s, Liebig wrote of the "rhetorical pompousness and bombast" of the contemporary generation of French chemistry, where "each tries to make himself

[874][874] Kanz, *Nationalismus Und Internationale Zusammenarbeit in Den Naturwissenschaften: Die Deutsch-Französischen Wissenschaftsbeziehungen Zwischen Revolution Und Restauration, 1789-1832 Mit Einer Bibliographie Der Übersetzungen Naturwissenschaftlicher Werke*, 205. Rudolf Stichweh, *Zur Entstehung Des Modernen Systems Wissenschaftlicher Disziplinen: Physik in Deutschland, 1740-1890* (Frankfurt am Main: Suhrkamp, 1984), 304 also cites this passage from Lichtenberg while exploring a more general German animus against French science in this period.
[875] Gert Schubring, "Changing Cultural and Epistemological Views on Mathematics and Different Institutional Contexts in Nineteenth-Century Europe," in *L'europe Mathématique: Histoires, Mythes, Identités*, ed. Catherine Goldstein, Jeremy Gray, and Jim Ritter (Paris: Editions de la Maison des sciences de l'homme, 1996), 366.
[876] August Wilhelm von Hofmann, *Zur Erinnerung an Friedrich Wöhler* (Berlin: F. Dümmler, 1883), 31.
[877] Volhard, *Justus Von Liebig*, 349.

conspicuous…and to awaken the highest opinion of him."[878] In the 1840s, Liebig assailed French chemistry for infringing on German and other research areas. "The procedure of [French chemist] Mr. Laurent is quite characteristic of the French school [of chemistry]...If German editors of [chemical] journals are to fulfill their duty [by turning down offending French manuscripts], our neighbors would very quickly be cured from the tendency to enrich themselves at the cost of foreign works." In a letter he wrote in 1841 to the Swedish chemist Berzelius he returned to his earlier complaint about French scientists, fuming that "[t]hese Frenchmen truly have no true [sic] feeling of honor, no sense of justice and fairness, they have for many years been occupying themselves with theoretical speculations that are useless for science, and solely to satisfy their own vanity and arrogance…"[879] He chastised the French for their chauvinism and high-flown rhetoric.[880]

Scientific superiority, once scented in chemistry in the German lands in the 1830s, elicited some corresponding condescension towards the national scientific rivals. The Germans were proud of the scientific renown they were increasingly gaining and at times jealous about the scientists of other nations who were granted total credit for achievements Germans thought that one or another German scientist should share in. Simply put, the Germans wished to be, and be acknowledged by the other nations as, the world leaders in science and learning (and in certain sciences as the unequaled leader) and ultimately in international influence. In a letter Hermann von Helmholtz sent his father in 1851, regarding the French reception of his first breakthrough paper, on the conservation of energy, published in 1847, he wrote that a French article had appeared that was quite negative in its appraisal of his work:

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[878] *Justus Von Liebig*, 330.
[879] Alan J. Rocke, "Pride and Prejudice in Chemistry: Chauvinism and the Pursuit of Science," *Bulletin for the History of Chemistry* 13-14 (1992-93): 32.
[880] Rocke, *Nationalizing Science: Adolphe Wurtz and the Battle for French Chemistry*, 90.

> That it [Helmholtz's conservation of energy publication] will be noticed in Paris, though perhaps not with a very good grace, is shown by a scoffing article in the *National*, by the reporter who has already been heckling [the German physiologist] du Bois-Reymond. Unluckily I have not been able to get hold of the article here. Don 't let this distress you: one cannot expect the French to take such things kindly from a German, and I have got all I want for the moment if they are alive to it.[881]

A new scientific reckoning was foreseen by the German observers not only with France but also with Britain. Both were older nations to which German lands had, gallingly, for a long period been inferior scientifically even if not also, arguably, culturally. Liebig favorably contrasted the conditions for authentic chemical discovery in German lands with those of France and Britain:

> [i]n a part of foreign lands where at one time chemistry stood at the highest level, now German [scientific] literature has become the measure of merit; the seat of public opinion [in chemical matters] is...in Germany [*Deutschland*] where it belongs. It cannot be in France, where the acknowledgement of a new fact, where the recognition of a service hangs on the dictates of a coterie. It cannot be in England, where true scientific sense is found only in a few individuals. It must be among us, where the position of those who pursue science through division into so many states brings about an absolute independence…"[882]

There was in Germany a sense of an overall international competition to advance learning.[883] Germans made sure to take the credit for their leading role in certain branches of science. For example, Ernst Schiff, in an article in 1889, cited Carl Ernst von Baer as the father of developmental history of the organism (ontogeny or *Entwicklungsgeschichte*).[884] In 1893, the German Universities' display catalog for the Chicago World's Fair, also designated Baer the

[881] Koenigsberger, *Hermann Von Helmholtz*, 66-67.
[882] Volhard, *Justus Von Liebig*, 327.
[883] citation in Burchardt, *Wissenschaftspolitik Im Wilhelminischen Deutschland: Vorgeschichte, Grundung Und Aufbau Der Kaiser-Wilhelm-Gesellschaft Zur Förderung Der Wissenschaften*, 19.
[884] Richard Hertwig, "Zoologie Und Vergleichende Anatomie," in *Die Deutschen Universitäten: Für Die Universitätsausstellung in Chicago 1893*, ed. Wilhelm Lexis and Richard Albrecht (Berlin: Asher, 1893), 98, 111.

father of *Entwicklungsgeschichte*, and Oscar Hertwig reinscribed this designation in his 1900 talk before the Scientists and Physicians meeting on the development of biology in the nineteenth century.[885]

The issue of national competition in its scientific guise continued to come up, as in regard to the *Physikalische-technische Reichsanstalt*, a project that was hanging fire in the 1880s. Helmholtz, who was later to be appointed its first director, recognized:

> [i]t is unworthy of a nation that has acquired by its power and intelligence, and has to maintain, a position in the front rank of civilized peoples, to leave the provision for such fundamental knowledge to other nations...Germany has already taken the lead by the institution of university laboratories for chemistry, physics and physiology; these have rapidly grown and multiplied, and have been imitated in all the surrounding countries.[886]

The physicist and meteorologist Wilhelm von Bezold in 1899, addressing a joint meeting of the Berlin Society for Geography and the German Colonial Society on the necessity for research in Antarctica, intoned, that

> [n]ow…when we look back at 1870, and at the time when our German heroes showed to an astonished world the extent of courage and daring present in the German people, things have changed. Today it is important to show the flag, to demonstrate Germany's might and power. We cannot allow others to carry out the plans we have formulated, plans which will benefit science and bring honor to the fatherland![887]

Germans' perception of their leading scientific role appeared in 1905 when the three prominent chemists organizing in support of a German Imperial Chemical Institute, in arguing for its funding, employed the notion of national scientific rank, the need to preserve for Germany

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[885]Emil Schiff and Carl Posner, *Aus Dem Naturwissenschaftlichen Jahrhundert. Gesammelte Aufsätze Von E. Schiff Nach Seinem Tode Herausgegeben Mit Einem Vorwort Von C. Posner* (Berlin: G. Reimer, 1902), 64. Hertwig, *Die Entwicklung Der Biologie Im 19. Jahrhundert: Vortrag Auf Der Versammlung Deutscher Naturforscher Zu Aachen Am 17. September 1900 Mit Einem Zusatz Über Den Gegenwärtigen Stand Des Darwinismus*, 11.
[886] Koenigsberger, *Hermann Von Helmholtz*, 372.
[887] citation in Brandon Luedtke, "Dividing Antarctica: The Work of the Seventh International Geographical Congress in Berlin 1899," *Polarforschung* 80, no. 3 (2010): 175.

its position "at the head of all peoples."[888] In 1906 the medical historian Karl von Sudhoff wrote of "…Germany's knowledge and ability [that] have developed into the instructress of cultural mankind."[889] Paul Ehrlich, the German immunologist, reveled in 1907 that "we are still today in the leading position. May the future keep this primacy from slipping from us."[890] Harnack remarked that the strength of Germany rested on the twin pillars of science and the German army.

> ...there is nothing so very suited for a people to solicit to the entire world and to let it appear as the leading culture bearer as the extension of human knowledge and the opening of new sources for the work and health of present and future generation. Therefore, leadership in the realm of the natural sciences has no longer only an ideational but it has also an eminently national and political worth. That this is bound also to an economic [worth] does not need to be shown.[891]

Taking the word "sciences" to mean all organized knowledge, the historian Ulrich von Wilamowitz-Moellendorff wrote, "We Germans will not take lightly the responsibility that has been placed upon us because we hold the leadership in sciences; the others know this too, even if they do not admit it."[892]

In viewing their land's striving against its national competitors, the German promoters of

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[888] Johnson, *The Kaiser's Chemists: Science and Modernization in Imperial Germany*, 52.
[889] Sudhoff, "Zur Grundsteinlegung Des Deutschen Museums Von Meisterwerken Der Naturwissenschaft Und Technik Am 13. Nov. 1906," 2251.
[890] Fritz Stern, *Einstein's German World* (Princeton, NJ: Princeton University Press, 1999), 25.
[891] Anonymous, *Jahrbuch 1951: 40 Jahre Kaiser-Wilhelm Gesellschaft Zur Förderung Der Wissenschaften 1911-1951*, 122.
[892] citation in Erdmann et al., *Toward a Global Community of Historians: The International Historical Congresses and the International Committee of Historical Sciences 1898-2000, Translated by Alan L. Nothnagle*, 69.

science commonly employed military figures of speech.[893] In 1862, for example, Helmholtz said, "[i]n fact, scientific practitioners are a kind of organized army. They strive for the best for the whole nation…"[894] There was a tendency to designate learning in terms of struggle as a means of supporting German aims in Europe and the rest of the world.[895] Du Bois-Reymond, in 1870, compared the just-begun war pitting the Germans against France to the two prior generations of cultural *siege* among the professoriate of France and Germany.[896] A German reporter on the conclusion in 1871 of a North Pole expedition of two German ships that had set out two years earlier, referred to the "triumphal procession of German science."[897] In 1878 August von Hofmann, who led the German effort at the London Exhibition of Scientific Apparatus two years earlier, using the language of feudal combat, also wrote of Germans' entering into the lists [*Schranken*] distinctively at the exhibition.

Werner von Siemens wrote in 1884 that "[i]n the current so vigorously waged battle of competition [Konkurrenzkampf], the nation that first ventures onto new lines [of natural science] and builds up the new branches of industry to be based on them has a decisive ascendancy."[898] Chemist Walther Nernst wrote that "scientific research…resembles a kind of war making…", while his fellow chemist Ernst Beckmann forewarned: "In the peaceful competition of nations, Germany can conquer only in the sign of scientific and industrial progress."[899] In 1909 Adolf von

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[893] Keller, "Discussion," 46; Kanz, *Nationalismus Und Internationale Zusammenarbeit in Den Naturwissenschaften: Die Deutsch-Französischen Wissenschaftsbeziehungen Zwischen Revolution Und Restauration, 1789-1832 Mit Einer Bibliographie Der Übersetzungen Naturwissenschaftlicher Werke*, 209 footnote 70.
[894] Ralph Jessen and Jakob Vogel, "Die Naturwissenschaft Und Die Nation: Perspektiven Einer Wechselbeziehung in Der Europaischen Geschichte," in *Wissenschaft Und Nation in Der Europäischen Geschichte* (Frankfurt am Main: Campus Verlag, 2002), 24.
[895] Turner, "Commentary," 297.
[896] Lenoir, *Politik Im Tempel Der Wissenschaft: Forschung Und Machtausübung Im Deutschen Kaiserreich*, 45.
[897] Adolf Pansch, "Uber Winter- Und Sommerleben Auf Der Deutschen Nordpolarfahrt," *Amtlicher Bericht über die Versammlung Deutscher Naturforscher* 44 (1871): 184.
[898] Warburg, "Werner Siemens Und Die Physikalisch-Technische Reichsanstalt," 795.
[899] citation in Johnson, *The Kaiser's Chemists: Science and Modernization in Imperial Germany*, 101, 02.

Harnack, appealing to the Emperor for his support of a new set of German research institutes, characterized the pursuit of science, both scientific and humanities research, as involving nations in "competitive strife" (*Wettstreit*).[900]

The German nationalistic voices speaking against foreign science, from quite limited initial resonance, gained an increased hearing. They were an early manifestation of the turn of the century German antimonies pitting scientific progress versus cultural pessimism with its aggressive criticism of civilization (the mechanical) as against culture (the spiritual) that lasted past the Weimar era into the Nazi period.[901] The misgivings even extended to German scientists if they were seen as too openly internationally amicable. There were German nationalist attacks in 1876, 1880 and 1890 on the purportedly "cosmopolitan" German scientists Hermann von Helmholtz and Emil du Bois-Reymond, seen as either partial to Britain or not sufficiently distant from non-German science.[902]

The outbreak of the European hostilities in 1914 brought a much sharper German mood than heretofore against Britain and British science. In the war's first month came the anti-British platform *England und Deutschland zur Zeit des Großen Krieges* (*England and Germany at the time of the Great War*) by Philipp Lenard, a Nobel laureate in physics and later Nazi advocate, while Nobel laureate in physics Wilhelm Wien distributed the same year an appeal for the German scientists to refuse to cite British science.[903] Of course, the wartime brought the most acute disparagement of the enemies' way of life and supposed thought patterns. What is

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[900] Anonymous, *Jahrbuch 1951: 40 Jahre Kaiser-Wilhelm Gesellschaft Zur Förderung Der Wissenschaften 1911-1951*, 123.
[901] Meinel, *Karl Friedrich Zöllner Und Die Wissenschaftskultur Der Gründerzeit: Eine Fallstudie Zur Genese Konservativer Zivilisationskritik*, 9; Wegener, "Science and Internationalism in Germany: Helmholtz, Du Bois-Reymond and Their Critics," 281.
[902] Wegener, "Science and Internationalism in Germany: Helmholtz, Du Bois-Reymond and Their Critics," 272.
[903] Philipp Lenard and Arne Schirrmacher, *Philipp Lenard: Erinnerungen Eines Naturforschers: Kritische Annotierte Ausgabe Des Originaltyposkriptes Von 1931/1943* (Berlin: Springer, 2009), 10-11.

significant here is that for the late nineteenth and early twentieth century Germans, especially when in dire straits, science held to be German in nature stood in for the Fatherland.

CONCLUSION

This chapter has presented nineteenth century science, and particularly German science, along multiple dimensions. The developments directly relating to science are a key backdrop for the dissertation's subsequent presentation of the heightened interest in the history of science in the period of the German Empire, from 1871. Evermore new heights in the level of the scientific findings impressed contemporaries; concurrently, past science and its development began to receive greater notice. The widespread feeling that German science stood in for the nation as a whole and spread its acclaim was increasingly extended to past German science, as science gained an enlarged cultural standing. International rivalries played out in the claims and contestations regarding science.[904]

Throughout the duration of the history of the German people, went the trope, they had manifested the sobriety, love of truth, and perseverance to extract her secrets from Nature. The myth-like (that is, seeming emergence from the depths of time) standing of German intellectual work, directed at natural phenomenon, could be an aid in solidifying the new German nation. Julius Kollmann, an important member of the German Society of Engineering, in the volume *Deutschland als Weltmacht*, suggested the importance of deep historical roots in the striving for the knowledge of nature for the past sense as well as the *current* sense of Germanhood:

> [a]fter the breakdown of the old culture, as the Germans from about the *thirteenth century* [my italics] introduced a new development, there arose as a signature of the new culture

[904] Knight, *The Making of Modern Science: Science, Technology, Medicine and Modernity 1789-1914*, 215 makes the argument more general, but the Germans would seem to be a particularly good case, as they advanced to be at the head of world science in the second half of the nineteenth century.

especially the pursuit of natural knowledge on the foundation of exact observation; for only from precise scrutiny of natural processes allows derivation of that which is lawful and its causes.[905]

[905] Kollmann, "Der Triumphzug Der Technischen Wissenschaften," 463.

CHAPTER VI:
THE NINETEENTH CENTURY GERMAN HISTORICAL BENT

Here I offer a chapter on the German turn to history along multiple lines in the late eighteenth and especially the nineteenth century.[906] The key points in the chapter are that modern historical scholarship had its advent in Germany, that the German historical scholarship led the world at this time, that there were a large number of elements in German life then that showed the influence of historical thinking and sensibilities, that the Germans' nineteenth century orientation to history was more profound and all-embracing than that exhibited elsewhere, and that the German historical bent was along with others one of the necessary preconditions to the early institutionalization of the history of science during the German Empire. The sources include general histories and early encyclopedias of nineteenth century Germany, past and present-day journal articles and monographs, a commemorative volume, symposia proceedings, the house organ of the German National Museum, and a dissertation.

The nineteenth-century upturn in historical consciousness was common to a number of lands, but by sometime in the nineteenth century, the German historical scholars as a group were outstripping their counterparts elsewhere, even as historical influences were penetrating German life widely.[907] Present-day historian Alfred Kelly refers to the "strong historical bent of much German thought" of this period, and James Sheehan uses the term "the triumph of history" for the same German phenomenon. [908]

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[906] Birt, *Deutsche Wissenschaft Im 19. Jahrhundert: Eine Rede Zur Jahrhundertwende, Gehalten Am 9. Januar 1900*, 13.
[907] Bardo Diehl, "Der Wandel Der Historiographie Von Medizin Und Naturwissenschaften in Ihrer Gesellschaftlichen Bedingtheit: 75 Jahre Karl-Sudhoff-Institut, Leipzig," *Sudhoffs Archiv* 66, no. 3 (1982): 277.
[908] Kelly, *The Descent of Darwin: The Popularization of Darwinism in Germany, 1860-1914*, 20. Sheehan, *German History, 1770-1866*, 542.

A key premise of this dissertation is that the erection of scientific historical displays was facilitated by the general climate of an attention to history in German lands, which was already underway during the late eighteenth century before, at the turn of the nineteenth century, the Napoleonic aggression set off patriotic cultural and political movements that reinforced the turn to the historical roots of the German people.[909] Then, seventy years later, the attainment of a unified Germany called forth efforts by German historians to interpret this crowning achievement in terms of the foregoing chapters in German(ic) history.

One historian has characterized the spirit of the first half of the nineteenth century in German lands as one of making it a purpose of the present, in the interest of a desired future, to reach back to the past.[910] Other disciplines besides history proper received the imprint of an historical approach. In the humanities, the historical-critical method was founded upon the use of analysis and a grounding in facts. Literary analysis adopted a historical frame.[911] The research ethos at German universities was in gradual evolution among the German professors from the late eighteenth century, involving a synthetic philosophical approach, the resort to history, and careful, empirically-based analysis.[912] In German, the word for science—*Wissenschaft*—applies to all (forms of) organized knowledge, and the research ethos in the German universities extended to all knowledge. The very pursuit of research connoted *tracing backwards* using *reliable sources*.

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[909] Sheehan, *German History, 1770-1866*, 544.
[910] Rudolf Vierhaus, "Einrichtungen Wissenschaftlicher Und Populärer Geschichtsforschung Im 19. Jahrhundert," in *Das Kunst- Und Kulturgeschichtliche Museum Im 19. Jahrhundert: Symposion Nürnberg (9.-11. April 1975)*, ed. Bernhard Deneke and Rainer Kahsnitz (Munich: Prestel, 1977), 109.
[911] Sheehan, *German History, 1770-1866*, 542-43.
[912] Jackson, *Spectrum of Belief: Joseph Von Fraunhofer and the Craft of Precision Mechanics*, 7. Jonathan Sperber, *Germany, 1800-1870* (New York: Oxford University Press, 2004), 137.

In the late eighteenth century and after, the German scholarly currents broadly reflected a turn to the historical; in jurisprudence, law, sociology, political economy, folkways and languages studies, and classical studies, roots were being sought.[913] Already there had been a wide elite interest in history in the German territories in the late eighteenth century.[914] James Sheehan asserts that a searching involvement with the past was characteristic of many eighteenth century German intellectuals and was a phenomenon of the *Aufklärung* (Enlightenment). Physics textbook author Bardo Diehl ties this tendency to those holding formal teaching positions: "[p]articularly in the sphere of German influence, the university and gymnasium teachers [in the late eighteenth and especially the nineteenth century] involved themselves, next to their professional activity in their original discipline...with the history of their discipline."[915] The German Enlightenment saw a greater preoccupation with the past as the centuries-long stability of the Holy Roman Empire was increasingly showing signs of failing. At the same time, reformers looked backwards for models in Greek or Roman antiquity.

Other disciplines in the German lands which early adopted a historical approach were linguistics, economics, art, law, philosophy, and theology.[916] A "change from a descriptive to a developmental way of thinking" in addressing various topics became part of the general

[913] Blackbourn, *The Long Nineteenth Century: A History of Germany, 1780-1918*, 89. Kaiser-Wilhelm-Dank and Verein-der-Soldatenfreunde, *Deutschland Als Weltmacht: Vierzig Jahre Deutsches Reich, Unter Mitarbeit Einer Grossen Anzahl Berufener Deutscher Gelehrter, Offiziere Und Fachmänner*, 456-57.
[914] Vierhaus, "Einrichtungen Wissenschaftlicher Und Populärer Geschichtsforschung Im 19. Jahrhundert," 109.
[915] Diehl, "Der Wandel Der Historiographie Von Medizin Und Naturwissenschaften in Ihrer Gesellschaftlichen Bedingtheit: 75 Jahre Karl-Sudhoff-Institut, Leipzig," 277.
[916] Demandt, "Natur- Und Geschichtswissenschaft Im 19. Jahrhundert," 39-40. See also Birt, *Deutsche Wissenschaft Im 19. Jahrhundert: Eine Rede Zur Jahrhundertwende, Gehalten Am 9. Januar 1900*, 14-15.

intellectual climate in the second half of the eighteenth century.[917] Research supported meticulous work in the classics, as for example in that of Friedrich August Wolf, whose late eighteenth century Latin study of Homer brought new credentials to classical scholarship as an autonomous field of study.[918] The German lands also became known for their historically-tinged brand of economics in the early part of the nineteenth century; prominent names of that era were Adam Müller and Friedrich List.[919]

While Richard Yeo has indicated that for Britain early in the nineteenth century, an interest in the history of sciences stemmed most generally from an advent of a historical awareness also seen in geology, archeology, and study of the medieval past, the German historian Franz Schnabel, terming the nineteenth century the "century of historical sense" in the German lands, maintained that the penchant for historical investigation spread *from there* to the Anglo-Saxon lands as well as to Eastern Europe.[920] Soon, in the nineteenth century, philological, legal, and historical "[s]tudies of the Fatherland [were] sprung out of the realism of the previous century, from German romanticism and its genetic cast of thought, from patriotic urges, from the need to tie together [*knüpfen*] again a lost continuity," according to Schnabel.[921]

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[917] Silvan Schweber, "Darwin and the Political Economists: Divergence of Character " *Journal of the History of Biology* 13, no. 2 (1980): 230-31.
[918] Suzanne L. Marchand, *Down from Olympus: Archaeology and Philhellenism in Germany, 1750-1970* (Princeton: Princeton University Press, 2003), 18. Schnabel, *Deutsche Geschichte Im Neunzehnten Jahrhundert -- Erfahrungswissenschaften Und Technik*, 69.
[919] Schnabel, *Deutsche Geschichte Im Neunzehnten Jahrhundert -- Erfahrungswissenschaften Und Technik*, 345, 485.
[920] Yeo, "Genius, Method and Morality: Images of Newton in Britain, 1760–1860," 265. Schnabel, *Deutsche Geschichte Im Neunzehnten Jahrhundert -- Erfahrungswissenschaften Und Technik*, 56, 60.
[921] Franz Schnabel, "Der Ursprung Der Vaterländischen Studien," *Blätter für deutsche Landesgeschichte Neue Folge* 88 (1951): 10.

By 1835 there was a German superiority in classical philology, ancient history, comparative linguistics, and biblical scholarship, at the same juncture that the tide of innovation shifted to the German lands in chemistry, the first German scientific discipline to attain a worldwide renown in modern times.[922] The German historical school of economics proper, formed of two somewhat disparate waves, centered on the 1840s and the 1870s.[923] The German reputation for scholarship, embracing historical scholarship in particular, continued to advance during the century. By 1902, more than halfway through the period of the German Empire, as the building blocks of a history of science discipline were being assembled, Karl von Sudhoff employed the rhetoric of rue to push for an ever closer application of the German historical impulse to the realm of the sciences: "[w]e've lost sight of the truth that any scientific discipline that forgets its history loses the honor of calling itself a science."[924]

THE GERMAN HISTORICAL IMPULSE

The Germans evidenced the turn to history in a host of ways. Early in the nineteenth century, the Germans sharpened their awareness of their identity as a people in part through their resort to their shared role in history. The first half of the nineteenth century was a time of historical thought in German learning and politics. History was generally accorded a high value

[922] R. Steven Turner, "German Science, German Universities: Historiographical Perspectives from the 1980s," in *"Einsamkeit Und Freiheit" Neu Besichtigt: Universitätsreformen Und Disziplinenbildung in Preussen Als Modell Fur Wissenschaftspolitik Im Europa Des 19. Jahrhunderts - Proceedings of the Symposium of the Xviiith International Congress of History of Science at Hamburg-Munich, 1-9 August 1989*, ed. Gert Schubring (Stuttgart: F. Steiner Verlag, 1991), 25; Marchand, *Down from Olympus: Archaeology and Philhellenism in Germany, 1750-1970*, 76.
[923] Ringer, *The Decline of the German Mandarins: The German Academic Community, 1890-1933*, 144.
[924] Karl von Sudhoff, "Zur Einführung," *Mitteilungen zur Geschichte der Medizin und der Naturwissenschaften* 1, no. 1 (1902): 1.

in education and upbringing in German culture in the nineteenth and early twentieth century.[925]

The spokesmen of the German unification movement from quite early early in the nineteenth century found it productive to invoke history.[926] The fostering of cultural, political and military history contributed to the building of a national identity.[927] A dominant strain in the German historical profession of the nineteenth century was nationalist, with the mid-century practitioners hearkening back to the resistance against Napoleon as the genesis of this historiographical trend. The German experience of the French Revolution, with its threat to the existing order, and the incursions of Napoleon into German lands, along with Napoleon's dictate that the Holy Roman Empire (in which German lands predominated) come to an end, drove residents to seek to secure their historical roots for reassuring signs of past intactness and the prospect of a future rise.[928] Although not all written accounts of German history early in the century presented it in national colors, a number of them did so. By mid-century the *national school* of historians were predominant in the discipline, while a narrative took hold, though not accurate, that this had already been the case from the time of the wars of liberation against Napoleon.[929]

In the nineteenth century, the attunement of the general populace of Germany to historical matters and the elevated status accorded to German historical scholarship affected one another in a dialectical relationship.[930] Both the academic and non-professional friends of history

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[925] Vierhaus, "Einrichtungen Wissenschaftlicher Und Populärer Geschichtsforschung Im 19. Jahrhundert," 110.
[926] Ibid., 115.
[927] Karin Friedrich, "Cultural and Intellectual Trends," in *19th Century Germany: Politics, Culture and Society 1780-1918*, ed. John Breuilly (New York: Oxford University Press, 2001), 112.
[928] Brose, *German History 1789-1871: From the Holy Roman Empire to the Bismarckian Reich*. Sheehan, *German History, 1770-1866*, 544. Vierhaus, "Einrichtungen Wissenschaftlicher Und Populärer Geschichtsforschung Im 19. Jahrhundert," 110.
[929] Stefan Berger, *The Search for Normality: National Identity and Historical Consciousness in Germany since 1800* (Providence: Berghahn Books, 1997), 22-23.
[930] Blackbourn, *The Long Nineteenth Century: A History of Germany, 1780-1918*, 306.

in German lands could agree that history was inspirational for the intellect and for artistic sensibility, and that the great German historical works of the nineteenth century could join works in the literary, graphic, plastic and musical arts for the Germans' edification.

The academic pursuit of history manifested the strength of the nineteenth century German attachment to history. Academic and scholarly history gained a greater distinction for nineteenth century German lands. If the nineteenth century was dubbed already in its own time the century of science, a leading contemporary German philosopher Heinrich Rickert, writing after the turn of the twentieth century, said that, in intellectual life, what was really "new in the [nineteenth] century was [in contrast to the preceding natural scientific centuries] more than anything else the achievements of the great historians who studied cultural history."[931]

Beginning before the 1815 Restoration in Europe supplanted Napoleon's hegemony, the German historical scholars of note included Barthold Niebuhr and August Boeckh, both of whom turned their attention to the ancient world. Researchers addressed Greek artifacts, as well as Roman and Middle-Ages artifacts discovered on German soil. Ancient history was pursued with an end in mind of its examples of virtue for the present. World history was cultivated for the examples of estimable actions that it offered.[932] Also, world history was invoked by the philosopher Georg Hegel, who sought, like Savigny, to ground the German spiritual life in historical research.[933] We will chart the further development of nineteenth century academic history in the German lands below.

In German literature, historical thinking got a foothold. Already in 1773 Johann

[931] Heinrich Rickert, *Kulturwissenschaft Und Naturwissenschaft*, 3 ed. (Tübingen: J.C.B. Mohr, 1915), 112 cited in Demandt, "Natur- Und Geschichtswissenschaft Im 19. Jahrhundert," 39.
[932] Vierhaus, "Einrichtungen Wissenschaftlicher Und Populärer Geschichtsforschung Im 19. Jahrhundert," 112.
[933] Schnabel, *Deutsche Geschichte Im Neunzehnten Jahrhundert -- Erfahrungswissenschaften Und Technik*, 62.

Wolfgang von Goethe encouraged the Romantic interest in the Middle Ages with his consideration of the fineness of the twelfth- through fifteenth century Strasbourg Cathedral and of the Gothic style in his work *Of German Architecture*.[934] Later attention, after the turn of the century, by Goethe to the beauty of the sculptural works of antiquity in his autobiographical *Aus meinem Leben: Dichtung und Wahrheit* was exemplary of the Romantic attention to the intrinsic value of such works.[935] Combined with this enthusiasm for antiquity, German Romanticism adhered to the national history as the roots of the people.[936] From 1799 there was a turn of the early Romantics to old German poetry, with the presumption that it should be an affair of the entire people, not just of the scholars. This turn was still underway with the five volumes of Gervinus's *History of the Poetic National Literature of the Germans* published between 1835 and 1842.[937]

In the late eighteenth and pre-unification decades of the nineteenth century, the rulers of individual German principalities, in order to implant a profound sense of their roots in their peoples, favored the support, and sometimes pushed the creation, of local and regional historical societies. Already before the nineteenth century, the rulers could build on a nascent interest in the past of the German communities. Journals and reading societies paid attention to history.[938]

Since the 1770s, there was an increase in historical, historical-political, historical-statistical, and historical-geographical newspapers.[939] These were often of regional emphasis, and were part, along with the readers' societies that consulted them, of the rise of autonomous

[934] Böhner, "Altertumssammlungen Des 18. Und 19. Jahrhundert Im Rheinland," 68, 63. Spies, "Die Kunst- Und Kulturgeschichtlichen Lokal- Und Regionalmuseen: Zeiten, Auslosenden Faktoren, Initiatoren Der Gründungen," 77.
[935] Böhner, "Altertumssammlungen Des 18. Und 19. Jahrhundert Im Rheinland," 61.
[936] Spies, "Die Kunst- Und Kulturgeschichtlichen Lokal- Und Regionalmuseen: Zeiten, Auslosenden Faktoren, Initiatoren Der Gründungen," 78.
[937] Vierhaus, "Einrichtungen Wissenschaftlicher Und Populärer Geschichtsforschung Im 19. Jahrhundert," 111.
[938] Ibid., 109.
[939] Ibid., 110.

bourgeois public participation—the people with interests in learning were able to pursue them in various associations, unencumbered by the need to produce research results. Initially prompted by the Enlightenment ideals for a widening of the participation in learning, and subsequently carried further by the Romantic movement, a confluence of the state and political influences prompted activity, particularly of the bourgeois, in regional history and its institutionalization into organized groups.[940]

The early patriotic societies of the late eighteenth century closely prefigured the nineteenth century historical associations and cultural historical museums.[941] A marked increase in the number of the associations for history and ancient studies, of interest especially because of the Roman presence in German lands in antiquity, became a distinctive feature of German nineteenth century life.[942] Local and regional history was actively pursued in the German lands by groups apart from academics and at a time preceding that of the innovation of chairs for history within the German university philosophical faculties.

From 1810 the historical collections with a national stamp began with one in Heidelberg, to be followed by others. In 1816 a group of Berlin professors submitted to the chancellor the so-called "Berlin Plan" for sponsoring a national museum of history, a bureau for artifact preservation, and an institute for the study of the people. The Berlin Plan was an early signpost of the tasks to be taken up later by art- and cultural-historical museums. As the historical societies developed, not infrequently during the nineteenth century they sponsored collections of

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[940] Hermann Heimpel, "Über Organisationsformen Historischer Forschung in Deutschland," *Historische Zeitschrift* 189 (1959): 190.
[941] Vierhaus, "Einrichtungen Wissenschaftlicher Und Populärer Geschichtsforschung Im 19. Jahrhundert," 110-11.
[942] Daum, "*Wissenschaft* and Knowledge," 157. Otto Dann, "Die Bürgerliche Vereinsbildung in Deutschland Und Ihre Erforschung," in *Sociabilité Et Société Bourgeoise En France, En Allemagne Et En Suisse, 1750-1850*, ed. Etienne François (Paris: Editions Recherche sur les civilisations, 1986), 48 and this was also true for German Switzerland, see same volume Ulrich Im Hof, "Vereinswesen und Geselligket in der Schweiz", 58.

historical artifacts, which led them to becoming the stewards of cultural historical museums.[943]

The rulers were behind such societies as long as these did not seem to bear the imprint of the national unification movement. Arising in the train of individual collectors' activities pursued in the later eighteenth century, local antiquarian societies and their collecting were much in evidence in the early- and mid-nineteenth century.[944] After the founding of a historical society in Frankfurt in 1819, other German societies using the Frankfurt society as a model soon proliferated.[945] In Bavaria King Ludwig I influenced the founding of local historical societies for the purpose of overseeing collections of artifacts, which ensued in that kingdom in the 1820s and 1830s.

In 1844, in the first volume of *Zeitschrift für Geschichtswissenschaft* (*Journal of Historical Research*), a publication that was extant for five years, the author of an article on the German historical societies made the following assessment revealing the attempt at a widening of interest: "An explicit goal of most [German historical] associations is the *general* [italics added] stimulation of the sense for the remains of the [German] past and the historical knowledge of them."[946]

By the 1850s, in one account, there were fifty regional historical associations, and by the late 1850s, in another account, there were over a hundred historical-antiquarian societies in the German lands.[947] These were performing significant services in "locating and preserving the monuments of antiquity and their usefulness for historical study, raising the awareness of many

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[943] Vierhaus, "Einrichtungen Wissenschaftlicher Und Populärer Geschichtsforschung Im 19. Jahrhundert," 110.
[944] Böhner, "Altertumssammlungen Des 18. Und 19. Jahrhundert Im Rheinland," 64-65.
[945] Karl Klüpfel, "Die Historischen Vereine Und Zeitschriften Deutschlands " *Zeitschrift für Geschichtswissenschaft* 1 (1844): 520.
[946] Ibid.: 546.
[947] Spies, "Die Kunst- Und Kulturgeschichtlichen Lokal- Und Regionalmuseen: Zeiten, Auslosenden Faktoren, Initiatoren Der Gründungen." Franz Schnabel, *Die Historische Kommission Bei Der Bayerischen Akademie Der Wissenschaften, 1858-1958* (Göttingen: Vandenhoeck & Ruprecht, 1958), 35.

old architectural treasures, researching and describing them and saving them from decay and destruction, aiding in their restoration, and putting in place collections of historical relics." In the second half of the century, the societies of history and antiquities sometimes operated using their own funds, but sometimes earned state funding.[948]

There was a premium on gaining influence on the behalf of the societies' activities: "the more that highly placed administrators can be brought on board...the more successful the efficacy of an antiquary association can be..."[949] Here, it seems that one, more commonplace, level of the bourgeoisie called on its upper reaches to sustain civic projects. Depending on the emphases of their societies, the members of the local and regional historical societies were variously nobles, propertied bourgeois or tradesmen, city officials, or in some cases craftsmen. They undertook the assembling and retention of historical documents and artifacts, including pictures. Their initial work was already making a difference in public attitudes towards historical relics. In 1844, Karl Klüpfel congratulated the historical societies for their recent activities to preserve the artifacts of the Middle Ages compared to ten or twenty years previously; at the time of the dissolution of the Holy Roman Empire in 1806, even the cultivated had willfully destroyed or modernized Middle Ages "monuments of the art of building."[950]

Historical societies' exhibits and museums were promoted as a means to build a patriotic sense of history among wide circles and the perception that the diverse objects of artistic, material and technical culture stem from a common source. It was through the societies that broader groups were drawn to history than was managed by academic history alone. There was

[948] Böhner, "Altertumssammlungen Des 18. Und 19. Jahrhundert Im Rheinland," 74.
[949] Klüpfel, "Die Historischen Vereine Und Zeitschriften Deutschlands ": 546.
[950] Ibid.

then a short but spirited wave of historical museum foundings in the wake of German unification.[951] By the late nineteenth century, there was a prevalence in Germany of cultural historical museums, proven crowd pleasers.[952]

During the German Empire, the impulse to mount presentations of relics already underway at mid-century was then further carried over to the foundings of permanent historical scientific exhibitions as well as to the organizing of counterpart, temporary displays. The tendency of cultural historical museums to downplay individual extraordinary merit artifacts set the stage for some of the historical scientific displays considered below, in which developmental lines were emphasized and each item in the series, even if not of outstanding execution or even if not associated with a "name" scientist, could be said to have "exhibition rights". Part of the presumption by members of the historical societies was that literary, pictorial and material things filled out each other's capacity to instruct and, combined, gave a total sense of the national past.[953] This credo was also followed in the main by the organizers of historical scientific displays. The German National Museum director Essenwein indicated exactly this regarding the in-house Pharmaceutical Central Museum.[954]

THE VIEW OF ACADEMIC HISTORIANS ON LOCAL HISTORY AND ON THEIR OWN MISSION

Academic historians could be intensely disparaging of the work of many local and regional historical groups. Many of them felt that the repute of the historical enterprise stood to

[951] Spies, "Die Kunst- Und Kulturgeschichtlichen Lokal- Und Regionalmuseen: Zeiten, Auslosenden Faktoren, Initiatoren Der Gründungen," 78-79.
[952] Sfedu, "Musemsgründung Und Bürgerliches Selbstverständnis: Die Familie Leiner Und Das Rosgartenmuseum in Konstanz", 50.
[953] Bernward Deneke, "Die Museen Und Die Entwicklung Der Kulturgeschichte," in *Das Kunst- Und Kulturgeschichtliche Museum Im 19. Jahrhundert: Symposion -- Nürnberg, (9.-11. April 1975)*, ed. Bernward Deneke and Rainer Kahsnitz (Munich: Prestel, 1977), 119.
[954] Anonymous: 80-82.

be cheapened by the shoddy practice among amateur historical devotees. For example, it was good for a laugh when some association members, eager "dilettantes and curiosity-mongers", got involved with digging at archaeological sites, describing in print every potsherd or ring found, indistinguishable from others of their kind, as though it was full of importance.[955] Some lay people, and even some experts, mistakenly apprehended that every notice published about an artifact or writing from antiquity was meaningful for the historical enterprise, with the result that such a mass of "useless odds and ends" was published on regional history that it was read "without appreciable profit".[956] Some of its promoters, according to this view, could not be taken seriously: for them, the true task of the antiquary associations was rather for the collective group to utilize all their contacts and connections to sniff out the presence of old writings, poems, documents, chronicles and letters, which tended to be the most rewarding relics, held in the collections of private individuals that could be purchased, exploited by select persons within the association, and so brought before the public.[957]

The academic historians were not against the activities of historical societies *per se*. The former saw good results published in some of these societies' journals. What they primarily objected to was the intemperate admixture of many husks among the corn. The disciplinary field of history was suspicious of the dilettantism of, for instance, the kind of assembling of disparate historical objects by Hans von und zu Aufsess, in the early days of the German National Museum that he had originated.[958] It is interesting to note the importance given to illustrating lines of development in display at the museum by a subsequent director Essenwein, and the emphasis on them was continued in introducing the museum's units relating to science.

[955] Klüpfel, "Die Historischen Vereine Und Zeitschriften Deutschlands ": 546-47.
[956] Ibid.: 550.
[957] Ibid.: 548.
[958]Vierhaus, "Einrichtungen Wissenschaftlicher Und Populärer Geschichtsforschung Im 19. Jahrhundert," 115.

Dilettantes who had neither learning nor inborn talent were not welcome to join their efforts to the more serious "pursuit of truth" that the historical guild saw itself as performing. And, according to some academics, the historical societies, in order to lend their efforts to bringing about an intensification of the common German spirit, also needed to join up into a national association.[959] They could pursue their independent researches, but these needed to have a platform under which all these researches worked towards a common end.

The cultivation of history was a potent means to inspire national feelings and stimulate the patriotic remembrance of the greater Germanic ethnicity. German historiography served the new national ideal through invocation of a "thousand-year old shared culture."[960] As the historian Dieter Langewiesche has pointed out, there was a penchant among the German nationalists of the early- and mid-century to call upon the entire span of Germanic history in attributing significance to the present-day German life.[961]

History books became popular and their authors widely renowned. Historian Karl Klüpfel commented in 1844, "For we study and cultivate history not solely to quench our thirst for learning, but so as to nourish the feeling of folk and lineage through the memorializing [*Erinnerung*] of the deeds, abilities and circumstances of our [German] predecessors."[962] After the turn of the century, the polemical edited volume *Deutschland als Weltmacht* signaled the important national work that had been done by the historian Treitschke, who penned a history of nineteenth century German lands (*Deutsche Geschichte im neunzehnten Jahrhundert* (*German History in the Nineteenth Century*) - 5 volumes from 1882), and by his fellow-historian Sybel

[959] Klüpfel, "Die Historischen Vereine Und Zeitschriften Deutschlands ": 533.
[960] Sfedu, "Musemsgründung Und Bürgerliches Selbstverständnis: Die Familie Leiner Und Das Rosgartenmuseum in Konstanz", 23, 30.
[961] Langewiesche, "Kulturelle Nationsbildung Im Deutschland Des 19. Jahrhunderts," 52.
[962] Klüpfel, "Die Historischen Vereine Und Zeitschriften Deutschlands ": 553.

(author of *Die Begründung des Deutschen Reiches durch Wilhelm I* (*The Founding of the German Empire under Wilhelm I*) - 7 volumes from 1889).[963]

Historical self-cultivation (*Bildung*) became an essential element of the nineteenth century national upbringing (*Nationalerziehung*).[964] In the introduction to the first issue in 1844 of the ambitious new *Zeitschrift für Geschichtswissenschaft*, the editor hoped that

> in the year when the thousand year independence of our Fatherland has been celebrated, in days when so much has been said about its political unification, which is more a wish than a fact: so...also might the idea take hold to set in place the cornerstone for more close imparting of the German [national] spirit…[965]

through the historical enterprise—singularly suited to ease divisions among Germans—as represented by the new journal. He continued, "Nothing can appear more desirable than a collection point of the diverse and disparate strivings of the German spirit in the realm of the historical discipline."[966] History, then, along with science, was seen as key to bringing the Germans together.

EMERGING NINETEENTH CENTURY GERMAN HISTORICAL EXPERTISE

A pair of aspects of the German past that received extensive attention in the nineteenth century, as outlined by scholar Karin Friedrich, were language and law. Just before the turn of the nineteenth century, Johann Herder had given stimulus to much subsequent feeling of a German commonality by his idea of the importance of belonging to a people holding over

[963] Kaiser-Wilhelm-Dank and Verein-der-Soldatenfreunde, *Deutschland Als Weltmacht: Vierzig Jahre Deutsches Reich, Unter Mitarbeit Einer Grossen Anzahl Berufener Deutscher Gelehrter, Offiziere Und Fachmänner*, 455.
[964] Josef Engel, "Die Deutschen Universitäten Und Die Geschichtswissenschaft," *Historische Zeitschrift* 189 (1959): 313.
[965] Adolph Schmidt, "Vorwort," *Zeitschrift für Geschichtswissenschaft* 1 (1844): iii-iv.
[966] Ibid.

centuries to a particular language.[967] Herder's work foreshadowed the development of the conception of a German *Kulturnation* with a distinct evolution along national lines, a rediscovery of German linguistic traditions, and a reexamination of the development of German law.[968] Another nineteenth century scholar whose work implicates German suffusion in history was Franz Bopp. His comparative linguistic work delved backwards to Sanskrit and allowed, for the first time, a secure base to trace ancestry and filiation of languages in Europe.[969] Bopp's attempt to track the modern tongues back to their origins allowed an orderly arrangement of the line of descent of languages, and was indicative of a general German disposition towards origins. The research of the philologist and folklorist Grimm brothers in the middle of the nineteenth century advanced the study of the German language. Especially Jakob Grimm approached the German tongue from an historical point of view.[970] The Grimm brothers created a source-based German philology which issued in their *Deutsches Wörterbuch* (first published in 1854), an etymologically-based, comprehensive German dictionary that has served as a standard work (with a new edition begun in 1957) ever since.

The legal scholar Savigny, affected by the Napoleonic upheaval, from his 1803 publication of "Right of Ownership", adduced the task of returning to the strict canon of Roman law as it had been in use among the Germanic tribes, after cleaning away later accretions: evidently, an uncertain present prompted in his mind a return to Germanic roots. For Savigny, the law-giving power puts freedom at risk when it dispenses with historical threads, and he was influenced by the German historian Niebuhr in the direction of combining historical and legal

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[967] Helmut Walser Smith, *The Continuities of German History: Nation, Religion, and Race across the Long Nineteenth Century* (New York: Cambridge University Press, 2008), 53.
[968] Friedrich, "Cultural and Intellectual Trends," 112. Schnabel, *Deutsche Geschichte Im Neunzehnten Jahrhundert -- Erfahrungswissenschaften Und Technik*, 73.
[969] Schnabel, *Deutsche Geschichte Im Neunzehnten Jahrhundert -- Erfahrungswissenschaften Und Technik*, 81-82.
[970] Ibid., 69, 73.

studies. He judged that the part of law that was *scientific* was limited to what could be studied from historical sources. Karl Friedrich Eichhorn, like Savigny affected strongly by the chaos of the Napoleonic period to search the past for models, in contradistinction to Savigny pointed in his legal teaching to the history of Germanic practices apart from their Roman law basis.[971]

Napoleon's introduction of French higher schools that would counter learning's static nature in his nation's universities also, paradoxically, led to reform within *German* universities—beginning with Prussia's.[972] The reform movement in German education was associated with the start of a new direction in history which initially drew inspiration from the philosophical school of Idealism embodied most directly in Hegel's works.[973] The trend to research had been strongly enhanced with the founding of Berlin University in 1810. At this institution, and subsequently elsewhere, research was made a mandatory component of professorial duties, and the professor-student exchange included the encouragement of student research. The seminar and the laboratory became the sites where this exchange occurred. The founder of the Berlin university, Wilhelm von Humboldt, sketched out what he saw as the historical profession's charge in 1821.[974] Already, within the neo-humanistic program that he envisioned for the universities, the study of history held an eminent place.

Historical German editing projects of large scope took hold at this time, which provided source material for "scientific" historical research. A Society for Study of Old German History (*Gesellschaft für ältere deutsche Geschichtskunde*) was founded in 1819 which conceived the plan to issue a complete edition of the German sources of the Middle Ages—the *Monumenta Germaniae Historica*—and this society became exemplary for the founding of German historical

[971] Ibid., 64-65.
[972] Engel, "Die Deutschen Universitäten Und Die Geschichtswissenschaft," 286.
[973] Ibid.: 303.
[974] Schnabel, *Deutsche Geschichte Im Neunzehnten Jahrhundert -- Erfahrungswissenschaften Und Technik*, 84.

societies in the 1830s and 1840s. The *Monumenta* was a publication of legal, social, and statecraft documents of the Middle Ages (and it has been continued until today). It was intended from the outset to embody not only scholarship but to be a gathering point for the interests of the advocates of history and of patriotically inclined people.[975]

As part of the German university reform, there was a movement away from the propaedeutic role of history in relation to other disciplines (such as in theology, jurisprudence, and cameralism whose professorships carried responsibility for teaching related history as well) in the direction of institutional parity for the historical discipline and clearer disciplinary standards, achieved at the German universities by the mid-nineteenth century.[976] Although professorial chairs joining statecraft and history, and in many cases chairs combining rhetoric with history, continued to exist well into the nineteenth century, the historical discipline also made big gains in autonomy with the allocation of university chairs solely for history within the university philosophical faculties.[977] Andreas Daum has recently commented on the changes underway: "…the critical examination and interpretation of archival and published sources, often within the framework of the history of a people or a nation, turned into a profession."[978]

In the 1830s and 1840s, cultural history took a pronounced place in German historical scholarship for the first time. Jacob Burckhardt, Wilhelm Heinrich Riehl, and Gustav Freytag (in a single, multi-volume work, *Bilder aus der deutschen Vergangenheit*) were initially its foremost German-language (in Burckhardt's case, Swiss) practitioners. From the 1830s, the German cultural historians developed an account of the bourgeoisie and its significance, treating

[975] Vierhaus, "Einrichtungen Wissenschaftlicher Und Populärer Geschichtsforschung Im 19. Jahrhundert," 112.
[976] Engel, "Die Deutschen Universitäten Und Die Geschichtswissenschaft," 285-86.
[977] Ibid.: 307.
[978] Daum, "*Wissenschaft* and Knowledge," 155.

economics as well as learning in general including the sciences.[979] Meanwhile, the non-academic pursuit of the interest in cultural history also gained speed. The idea took hold that the people as a whole, rather than just scholars, should sustain the historical memory. As modernization proceeded, a feeling of insufficient inbuilt tradition-sense that had emerged among the general population increased its sense of needing a degree of participation in historical activity.[980]

The Germanisches Nationalmuseum was a cultural-historical institution with a national imprint. Hans von und zu Aufsess, a Bavarian nobleman, the Germanisches Nationalmuseum's founder, had been trying to form a *national* cultural historical museum since 1830, when the Bavarian King Ludwig I and he had conferred about the setting up of a cultural historical museum in Bamberg. The museum, once established in Nuremberg in 1852, served to support the patriotic feelings in the period before unification and then afterwards (see Chapter 3 for coverage of its scientific division, its Central Pharmaceutical Museum, and its Medico-historical Cabinet.)

There were numerous cultural historical museums founded from the 1850s. A project with regional patriotic overtones was the cultural historical Bavarian National Museum founded in Nuremberg by Bavarian King Maximilian II in 1855. This institution, more than the Germanisches Nationalmuseum, was mainly suited to serve the patriotic purposes of the House of Wittelsbach, the Bavarian ruling dynasty.

Commonly, individuals formed collections, and societies formed museums.[981] Sometimes libraries were attached to these museums, a pairing later reflected in certain German institutions

[979] Schleier, "Neue Ansatze Der Kulturgeschichte Zwischen 1830 Und 1900. Zivilisationsgeschichte Und Naturgesetze. Darwinismus Und Kulturbiologismus," 139-40.
[980] Vierhaus, "Einrichtungen Wissenschaftlicher Und Populärer Geschichtsforschung Im 19. Jahrhundert," 110-11.
[981] Böhner, "Altertumssammlungen Des 18. Und 19. Jahrhundert Im Rheinland," 67, 73.

for science history.[982] In cultural historical museums, there was no separation of the artistic objects from other objects. The favoring of select works according to artistic value, such as was commonly done at art museums, was not upheld by these museums.[983] All objects were shown together according to time period, each a document gaining credentials as a *cultural* relic. An assumption of the historical societies was that the collection of past objects, even fragments, can prove edifying when lined up together with certain other objects.[984]

Many of the academic historical discipline's most famous and influential nineteenth century figures were Germans, including Niebuhr, Ranke, Droysen, Theodor Mommsen, Treitschke, and Lamprecht. Niebuhr was claimed in a 1911 commemorative text on Germany as the first to bring a scientific use of historical materials to the discipline.[985] Ranke it was whose name became synonymous with the historical seminar, and who took up the question of the emergence of western culture and argued for its coherence. He painted history in broad strokes, bringing together the specific with the most general, writing the histories of nations and tracing the interconnections among them, while continually introducing the lineaments of a world history. His influence in method, foregrounding the critical use of sources, extended beyond the German borders, though it would, according to Georg Iggers, be inaccurate to speak of his having brought about a scientific revolution in methodology, source-based methods having been already in use for a long time previous to his work, if never before so trenchantly.[986] In any case,

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[982] Ibid., 73.
[983] Spies, "Die Kunst- Und Kulturgeschichtlichen Lokal- Und Regionalmuseen: Zeiten, Auslosenden Faktoren, Initiatoren Der Gründungen," 80.
[984] Deneke, "Die Museen Und Die Entwicklung Der Kulturgeschichte," 119.
[985] Kaiser-Wilhelm-Dank and Verein-der-Soldatenfreunde, *Deutschland Als Weltmacht: Vierzig Jahre Deutsches Reich, Unter Mitarbeit Einer Grossen Anzahl Berufener Deutscher Gelehrter, Offiziere Und Fachmänner*, 451.
[986] Schnabel, *Die Historische Kommission Bei Der Bayerischen Akademie Der Wissenschaften, 1858-1958*, 95. Georg G. Iggers, "The Crisis of the Rankean Paradigm in the Nineteenth Century," in *Leopold Von Ranke and the Shaping of the Historical Discipline*, ed. Georg G. Iggers and James M. Powell (Syracuse: Syracuse University Press, 1990), 71.

Ranke's contribution was signal: no less an attestor than King Maximilian II of Bavaria intimated Ranke's bestowal on the historical profession of "the principal of free…research and free teaching."[987]

In the view of the historian Rudolf Vierhaus, it is notable that Ranke and other significant narrative historians of the nineteenth century were successful in convincing their readers of the scientific basis of their work, of their having brought the techniques of research to an advanced point, and of their achieving an objective account. History in large part began to stand in for philosophy as an explanation of how the present conditions had been bred. There was a pronounced demand for historical works, and the attribution of an individual's *Bildung* came to depend in part on his or her possession of an historical understanding.[988] But discussions from mid-century over the method to be used in historical research showed that "scientific" in regard to history had a different meaning than in the natural sciences. In fact, the method to be used in history was being pinpointed against the backdrop of the method appropriate to the natural sciences.[989]

A striking event revealing of the turn to the historical in German lands was the appearance from 1859, its success initially largely due to the diligence of its chief editor Heinrich von Sybel, of the *Historische Zeitschrift* (*Historical Journal*). This general historical journal was the first of its kind in German lands—barring two short-lived predecessors—and only the third in Europe, the other two originating some twenty years earlier in Denmark and the Netherlands. It continues publication to this day. The work of the *Historische Zeitschrift* represented an attempt

[987] Engel, "Die Deutschen Universitäten Und Die Geschichtswissenschaft," 324. footnote 1.
[988] Rudolf Vierhaus, "Historiography between Science and Art," in *Leopold Von Ranke and the Shaping of the Historical Discipline*, ed. Georg G. Iggers and James M. Powell (Syracuse: Syracuse University Press, 1990), 66-67. Vierhaus, "Einrichtungen Wissenschaftlicher Und Populärer Geschichtsforschung Im 19. Jahrhundert," 113.
[989] Demandt, "Natur- Und Geschichtswissenschaft Im 19. Jahrhundert," 49.

to penetrate the public consciousness with the relevance of an historical understanding for a proper appreciation of the present task of German nation-building, as well as to instill pride within an expanded audience for the work of the German academic historians, which the profession in the German lands believed had succeeded in recent decades in putting history on a consistently scientific footing for the first time anywhere.[990] The *Historische Zeitschrift* held fast to its aim to bring about an appreciation for history among more non-specialists: Sybel considered that "history is the leaven [*Ferment*] of universal *Bildung*".[991]

GERMAN HISTORICISM

Historian Georg Iggers maintains that German historicism (*Historismus*) was part of a larger European movement, but represented its most radical elaboration.[992] The broad movement of historicism, which is most well known with regard to the discipline of history, also spread beyond it to other disciplines in the German lands. Of research-based disciplines looking to trace developments over time and thus using historical axes, philology and history itself were the first to be securely grounded at the German universities, and in fact study in these two areas was linked.[993] Scholars J.G. Herder (late eighteenth century) and August Boeckh (early nineteenth century) considered that in pursuing history, they were essentially involved in philology.[994]

[990] Theodor Schieder, "Die Deutsche Geschichtswissenschaft Im Spiegel Der Historischen Zeitschrift," Ibid.189 (1959): 4.
[991] Ibid.: 16.
[992] Georg G. Iggers, *The German Conception History: The National Tradition of Historical Thought from Herder to the Present* (Middletown, CT: Wesleyan University Press, 1983), 6.
[993] Sheehan, *German History, 1770-1866*, 545.
[994] Brose, *German History 1789-1871: From the Holy Roman Empire to the Bismarckian Reich*, 146.

Standards for source-based research in philology took shape in the German universities already in the late 18th century, while for research in Russian history A.L. Schlözer introduced the credo of critical methods in the last decades of the eighteenth century.[995] This acute turn toward their activity as what the historian Dorinda Outram terms "a self-conscious[ly] relativistic and critical" one took hold more broadly among the historians in the first half of the nineteenth century. Assessing this change, Outram states that "[t]he growth of a body of critical techniques [within the historical discipline]…forced attention not only on the *content* of history but also on the *processes* of human cogitation and intuition by which the content of history was established."[996] The reconfigured approach to historical activity replaced that based on what has been referred to as the characteristic "collecting of chance curiosities" of the German eighteenth century. Speaking of the collecting of relics in the Rhineland, for example, Kurt Böhner intimates that they "created a great enthusiasm as historical rarities but due to limitations of interpretative options, were more objects of scientific fantasy than of scientific knowledge."[997]

Historicism held that history is produced by conscious human agents, with differing contexts at different times, and the historian's own position within time must also be taken up.[998] The refinements of historicism were not in the main to carry over to late nineteenth century history of *science*, attesting to the professional divide between academic historians and those scientists who took up a scholarly activity in the history of science. However, one aspect of

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[995] Gabriela Lehmann-Carli, *Göttinger Und Moskauer Gelehrte Und Publizisten Im Spannungsfeld Von Russischer Historie, Reformimpulsen Der Aufklärung Und Petersburger Kulturpolitik: Mit Einer Quellentextausgabe Von Teilen Der Korrexpondenz Zwischen Den Moskauer Universitätsprofessoren Johann Gottlieb Buhle Sowie Christian August Schlözer Und Dem Kurator Der Moskauer Universität Nikail Nikitic Murav'ev Aus Den Jahren 1803 Bis 1807* (Berlin: Frank & Timme, 2008), 59.
[996] Dorinda Outram, *Georges Cuvier: Vocation, Science, and Authority in Post-Revolutionary France* (Dover, NH: Manchester University Press, 1984), 150.
[997] Böhner, "Altertumssammlungen Des 18. Und 19. Jahrhundert Im Rheinland," 73.
[998] Iggers, *The German Conception History: The National Tradition of Historical Thought from Herder to the Present*, 4-5.

historicism did exert its influence across disciplines: it posited that all doctrines entailing explanation must have recourse to history, and thus even the natural sciences should be presented from a historical perspective.[999] An incipient specialization in the scholarly history of science beginning late in the century was a natural outgrowth of this aspect of the historicist approach.

Most academic historians holding nineteenth century German university chairs saw their nation's history as a potent means to inculcate a common German spirit. Indeed, the urgency for them to follow this path almost constituted a "no brainer" at the time. Later investigations have termed the sense of mission, brought into focus by the period's German academic historians, "Borussian." In what was *contemporaneously* referred to as the "*Gothaic* conception of German history", there may have been a degree of lock-step among German academic historians. Contemporary historian Onno Klopp claimed in 1862 that only one in four German historical journals were *not Gothaic*. What the rubric entailed, beyond movement towards a unification under Prussia with the exclusion of Austria, was a generally liberal outlook, with some form of a parliamentary body, and a reverence for Frederick the Great for his vision to build up a strong German state.[1000] Klopp regretted that the Gothaic conception's "principles were professed like axioms. It dominates the discipline so completely, that any doubt of its rightness...is scorned as a doubt of the perpetrator's objectivity. This we call the 'German historical school' [*die deutsche Geschichtschreibung*]. Most of those with a claim to *Bildung* follow this trace blindly."[1001] Adopting consensus academic historical practices, a number of the German scholars, highly-trained archival researchers, made the case that their nation was vital and righteous and thus that

[999] Daum, "*Wissenschaft* and Knowledge," 154.
[1000] Onno Klopp, *Die Gothaische Auffassung Der Deutschen Geschichte Und Der Nationalverein Mit Beziehung Auf Die Schrift Des Herrn Von Sybel: Die Deutsche Nation Und Das Kaiserthum* (Hannover: Klindworth, 1862), 17.
[1001] Ibid.

its success was a moral issue.[1002]

Collapse of the movement for an all-German unification of 1848-1849 had left tangible political progress toward a common German nation uncertain for a time. The North German Protestant national-liberal historians, among them prominently Heinrich von Sybel, from the 1850s consequently took a stand against any unification under Austria with its orientation to the southern German states and its Catholic confession. These historians reconfigured a disparate central European past of the German lands into a story implying an inexorable movement towards a powerful German state combined with a repudiation of outside influence. This refashioned account was effective in demoting various strands of religious, dynastic, or regional histories to a reduced part in the German story. Besides Sybel, the other members of the "Borussian school" of history included Johann Droysen, Theodor Mommsen and Heinrich von Treitschke, who resorted to the press and to conference presentations to make their case for a unified German nation led by a majority-Protestant Prussia.[1003]

By the second half of the nineteenth century, there had been an historical seminar originated at each of the German universities for scientific (intense and rigorous) historical work by students.[1004] In the main, the development of research capability was the foremost aim of these German university historical seminars.[1005] They too presupposed group work, indeed putting such work on a much more regular basis, with the apprentice historians-in-the-making delivering relevant materials in keeping their masters' scholarly directions. In 1874, published

[1002] Konrad Jarausch and Michael Geyer, *Shattered Past: Reconstructing German Histories* (Princeton: Princeton University Press, 2003), 41-42.
[1003] Wehler, "Der Nationalstaat Ensteht: Gegen Die Dynastien," 104.
[1004] Engel, "Die Deutschen Universitäten Und Die Geschichtswissenschaft," 330.
[1005] Ibid.: 330-34 footnote 2.

serial studies produced by such seminars began to appear, first off under Johann Droysen, followed by three more series in the 1880s, with a number of additional university historical seminars following suit before World War I.[1006] Increasingly, history dissertations were published in book form.[1007]

As an example of the German bourgeoisie's putting its stamp on the cultural and patriotic projects in the second half of the nineteenth century, Hermann Heimpel has cited the period's group historical editing projects—whose labor sometimes reached beyond the scope of a single professional lifetime, such as the editing of the acts of the Holy Roman Empire's *Reichstag*, publishing initiated in 1867—or which involved a large-scale institutional reach, such as the editing of the catalogues of the libraries of Germany, Austria and Switzerland, appearing from 1893.[1008]

Materialist philosopher Ludwig Büchner, summarizing the knowledge of the nineteenth century at the end of that century, wrote that history, unlike theology, philosophy, and jurisprudence, had made actual progress.[1009] The evidence for the effect of the work of that period's publicists' to heighten the awareness of the achievements of the German historians was the assertion by now recently-deceased leading German historian Hans-Ulrich Wehler that history in the period leading up to the national unification was held by the educated elite to have been the foundational science. The museum director and historian Tatiana Sfedu extends the period of this judgment, holding that history had risen to be, in 1871, the leading science.[1010]

[1006] Hermann Heimpel, "Über Organisationsformen Historischer Forschung in Deutschland," Ibid.: 144 - 1 45, 1 53.
[1007] Ibid.: 144-45.
[1008] Ibid.: 153, 57.
[1009] Büchner, *Am Sterbelager Des Jahrhunderts: Blicke Eines Freien Denkers Aus Der Zeit in Die Zeit*, 57-58.
[1010] Wehler, "Der Nationalstaat Ensteht: Gegen Die Dynastien," 104. Sfedu, "Musemsgründung Und Bürgerliches Selbstverständnis: Die Familie Leiner Und Das Rosgartenmuseum in Konstanz", 31.

THE HISTORICAL IN THE REALM OF THE SCIENCES

In the nineteenth century, an historical orientation extended to natural science in various lands, among them the German lands. William Coleman traces this development across the sciences in a 1971 publication. Already prepared for by the eighteenth century's attention to the earth's structure, various theories of the process by which the earth underwent change were floated. By 1800 there were essentially two competing historical theories, one (espoused by the Neptunians, supporting the German geologist Werner) ascribing change in the earth primarily to precipitation from its mass of liquid, another (held by the Plutonists, supporting the Frenchman Abbé Anton Moro and the Briton James Hutton) to consolidation of sediment and uplift due to heat.[1011] The latter theory was termed uniformitarianism, as it propounded that all of the forces contributing to the earth's formation were still in evidence contemporaneously, and that a part of the process was a very gradual weathering down of rock uplifted through volcanic activity. That theory thus also vastly extended the supposed duration of geological time, a factor which subsequently proved important for the entertainment of various ideas regarding species evolution.

Along with geology, another area of science in which a historical turn was taken in the nineteenth century generally was in the realm of biology, itself only named as its own science at the beginning of the century. This historical turn was in evidence in two separate branches of biology which were portentous in German lands. Embryology was a central focus of nineteenth century biology, and beginning in the late 1830s the Germans took over the French lead in microscopy.[1012] The German embryological research, associated with much use of microscopy, made its impact felt for the remainder of the century and beyond. A developmental, historical

[1011] Coleman, *Biology in the Nineteenth Century: Problems of Form, Function, and Transformation*, 61.
[1012] Ibid., 36, 56, 25.

approach to embryology took hold with the cell theory developed by two Germans, Matthias Schleiden and Theodor Schwann, in the 1830s. The second scientific discourse in biology that adopted a historical approach was the eponymous Darwinian (r)evolution, which found many supporters in the scientific community in Germany soon after its introduction in 1859 by the Briton Charles Darwin: in this doctrine, it was species which underwent development, or descent with modification—that is, a history of species could potentially be recounted.[1013]

Finally, as Coleman asserts, the emerging science of man, drawing on physical anthropology, human paleontology, and archeology, derived a historical bent from a complex of sources. This new science surveyed the nature of the overall development of mankind. Collectively, the science of man de-emphasized exact chronology in favor of a doctrine of stages of development. Embracing psychology, anthropology and sociology, it amounted to a science of civilization.[1014]

GERMAN HISTORICAL WORK APPLIED TO SCIENCE

Particularly in scholarship and in exhibition, the Germans during the Empire showed a dedication to the history of science. The history of science did not emerge from *within* the academic discipline of history in German lands after mid-century; its main scholarly exponents, rather, were scientists. This led German academic historians to consider that the accounts written on topics in the history of science belonged to the disciplines of science, not to that of history. However, most scientists had received a humanistic education at least through their *gymnasium*

[1013] Ibid., 57.
[1014] Ibid., 94.

(secondary school) training.[1015] There, they would have had some exposure to the study of history and philology and textual criticism practiced by the researchers in these disciplines.[1016] The Germans who disposed of a university education perhaps acquired on average a wider mental horizon than that attained elsewhere, with the *Bildung* (refinement/development) they had acquired at secondary schools further advanced at universities through a diverse curriculum and the freedom to repeatedly shift from one to another German-language university, the famed *Lernfreiheit* (freedom to learn).[1017] What German university students, including students in the scientific disciplines, were exposed to constituted a broad enough curriculum that they could hardly avoid at some point facing issues presented in philosophy, for example.[1018] The upshot was that "…German scientists [were]…informed and…self-conscious about the status of their disciplines…"[1019] Such a rich educational background worked positively in moving some scientists towards an urgent interest in the humanities, some gravitating towards research in and writing on the history of science.[1020]

On the other hand, the German historians of science Christoph Meinel and Christoph Scriba have underlined that few scientist-historians had received a full training in academic historical practice, so that there was a limited introduction of the methods developed there into

[1015] Laudan, "Histories of the Sciences and Their Uses: A Review to 1913," 3 states that nineteenth century practitioners of science who had attended classical high schools in Germany, France and Britain were "scientists by avocation but humanists by training...".
[1016] Meinel, "German History of Science Journals," 81.
[1017] Vierhaus, "Einrichtungen Wissenschaftlicher Und Populärer Geschichtsforschung Im 19. Jahrhundert," 115.
[1018] Yehuda Elkana, *The Discovery of the Conservation of Energy* (Cambridge: Harvard University Press, 1974), 155.
[1019] Knight, *The Making of Modern Science: Science, Technology, Medicine and Modernity 1789-1914*, 222.
[1020] Scriba, "The Beginnings of the International Congresses of the History of Science," 6.

the initial work in the history of science and medicine. Meinel also intimates that the divide between science and the arts played a role in distancing the German history of science writings, produced by the scientist-historians, from the methods of the academic historians.[1021]

Thus, there was something of a disconnect between the practitioners of academic history and those of the history of science during the German Empire.[1022] The historians' guild insisted on a top-down, state-centered, history, "and found in [the State]…the ruling category…" of their work."[1023] They paid little heed to the role of science in history, and were inclined to think the the scholarship done in the history of science to be suspect, if for no other reason than the lack of academic training in history characterizing those who had produced it. Further, the general historians assigned the scholarship done in the history of science to the domain of the sciences rather than to that of the humanities. As regards the participation of engineers such as Oskar von Miller in setting forth the history of science and technology, a recent work on the place of technology in Germany found that "[t]he established historians' guild in Wilhelmine Germany was far from conceding a cultural asset status to engineers."[1024]

HISTORY AND GERMAN NATIONAL SELF-ESTEEM

German historians during the Wilhelmine (1871-1918) period equated German

[1021] Meinel, "German History of Science Journals," 81. Scriba, "The Beginnings of the International Congresses of the History of Science," 4.
[1022] Kragh, *An Introduction to the Historiography of Science*, 14.
[1023] Glaser, *Bildungsbürgertum Und Nationalismus: Politik Und Kultur Im Wilhelminischen Deutschland*, 137. Georg G. Iggers, "The Dissolution of German Historicism," in *Ideas in History: Essays Presented to Louis Gottschalk by His Former Students*, ed. Richard Herr and Harold T. Parker (Durham, NC: Duke University Press, 1965), 289.
[1024] Burkhard Dietz, M. Fessner, and Helmut Maier, "Der 'Kulturwert Der Technik' Als Argument Der Technischen Intelligenz Fur Sozialen Aufstieg Und Anerkennung," in *Technische Intelligenz Und "Kulturfaktor Technik": Kulturvorstellungen Von Technikern Und Ingenieuren Zwischen Kaiserreich Und Früher Bundesrepublik Deutschland*, ed. Burkhard Dietz (New York: Waxman, 1996), 16.

singularity with superiority, so history as a field and a popular pursuit was suited to sustaining the German national self-esteem.[1025] A particularly good assessment of the new prominence in the German lands of the discipline of history is given by Josef Engel:

> The time between the mid-eighteenth century and the late 1880s is truly the period in the history of knowledge, lasting but a single generation, in which German history, grown up as a discipline in proud self-confidence and great general inner unity, experienced the golden age of its development…[I]ts certainty in its being valid knowledge and its trust in the correctness of the path it had embarked on…were never greater than at that time. The exaltation that the kings of the discipline had produced was borne also by its laborers, who, disappearing into specialized investigations, understood how to be borne aloft by the major enterprise [*Grossbetrieb*] of knowledge. This knowledge, expanding in this period to an unimagined scope, had become almost an end in itself.[1026]

One added piece of evidence revealing the extent to which an historical approach guided thought during the Imperial era was Rickert's proposal during the First World War that, along formal lines, all of the branches of knowledge could be grouped into either natural scientific or historical sciences (where the latter comprises all knowledge related to cultural life). He even claimed that within natural sciences a degree of historical method inheres.[1027]

A pertinent example of the continuing hold of the historical motif on German thinking, as well as its application to science, is the approach taken by the Deutsches Museum in acquiring and displaying objects. One of its advisors, the physicist Leo Graetz, himself the son of a historian, eloquently appraised the distinctive place of progression, of rungs of development, in the museum's policy in 1906, the year that it opened. Already, he felt,

> the museum has become a true representation of the history of the great...progress of the full range of the natural scientific and technical disciplines. Now, with this new point of view, it is entirely unimportant whether an exhibited machine, whether a displayed apparatus, has merely the material worth of its old iron, indeed it is also not relevant, whether it has value as an object of piety for this or that group of mankind. Now it has...its worth as the depiction of a specific moment in historical development…It has a

[1025] Hewitson, "*Nation* and *Nationalismus*: Representation and National Identity in Imperial Germany," 30.
[1026] Engel, "Die Deutschen Universitäten Und Die Geschichtswissenschaft," 352.
[1027] Heinrich Rickert, *Kulturwissenschaft Und Naturwissenschaft*, 3 ed. (Tübingen: J.C.B. Mohr, 1915), 16-18.

> historical place as the end or the beginning or...middle of a longer line of development…[T]he museum portrays for us now a history of the development of human intellect, in the way that it gradually has compounded in connection with its experience of Nature.[1028]

The historical parade or pageant, often staged as a re-enactment, was arguably a most characteristic manifestation during the German Empire.[1029] Some parades were organized by the state. At others, the bourgeoisie seized the opportunity to render visible its engagement with the historical tradition of the German state.[1030] And, by definition, the parades occupied public space and were potentially seen by people of all conditions, widening the bourgeoisie's legitimacy as a leading power in Germany. They were also recreations of a former hierarchichal society in which social harmony had obtained, and for which the bourgeoisie yearned as it viewed the strengthening workers' movement. Big theatrical pageants adorned the celebrations of Albrecht Dürer's four hundredth birthday in 1871 and Martin Luther's four hundredth birthday in 1883. Especially during the rule of Wilhelm II stylized festivities were performed many times over.[1031]

The erection of monuments was a way other than historical writings, associations or collections, or parades and pageants, to register, and glorify, the past. Historian Frank Lorenz Müller speaks of the Reich's "craze for monuments."[1032] Already in the first decade of the nineteenth century, Bavarian ruler Maximilian I conceived of an honorary edifice of massive classical proportions sitting over the Donau River near Regensburg. This project was taken up again by his successor Ludwig I, who commissioned the building of the site beginning in 1830

[1028] Graetz, "Die Bedeutung Und Die Aufgabe Des Deutschen Museums," 290.
[1029] Glaser, *Die Kultur Der Wilhelminischen Zeit Topographie Einer Epoche*, 215.
[1030] Applegate, "Localism and the German Bourgeoisie: The 'Heimat' Movement in the Rhenish Palatinate before 1914," 242.
[1031] Glaser, *Die Kultur Der Wilhelminischen Zeit Topographie Einer Epoche*, 216.
[1032] Müller, *Our Fritz: Emperor Frederick Iii and the Political Culture of Imperial Germany*, 252. Koshar, *From Monuments to Traces: Artifacts of German Memory, 1870-1990*, 24 where the author highlights Emperor Wilhelm II's affinity for memorials.

and named it Walhalla. In the building's interior were housed monuments depicting the great German thinkers and statesmen. Other major monuments, including the Bavarian Hall of Fame (*Ruhmeshalle*) in Munich, begun in 1834, and the Liberation Hall (*Befreiungshalle*) in Kelheim, begun in 1842, celebrated the Bavarians and the other Germans of the past.[1033] Altogether the nineteenth century in the German lands was dotted with imposing monuments.[1034]

The incipient nationalism embodied in these monuments was also present in the numerous scientific memorials erected in German lands in the nineteenth century, most prominently during the German Empire, detailed in Chapter 1. Like the majority of the displays of scientific relics, the public memorials to the scientists accented that the history of science was not exclusively an affair of specialists—it concerned the general population of Germany, insofar as it heightened the image of his/her nation borne by the common citizen.

With the new historical consciousness of the nineteenth century, there was a penetration of historical awareness into the diverse aspects of life. The general penetration of an historical approach in German neohumanist *Gymnasien* (classical high schools) and universities was contemporaneous with a widespread historical interest that extended beyond that of the highly educated.[1035] German architecture borrowed from or recreated past styles, painters drew on historical subjects.[1036] Reconstructions of quarters or streets of old towns in German lands--Berlin, Nuremberg, Vienna—proved to be favorites at exhibitions (this was far from uncommon,

[1033] Friedrich, "Cultural and Intellectual Trends," 113.
[1034] Glaser, *Die Kultur Der Wilhelminischen Zeit Topographie Einer Epoche*, 226. Koshar, *From Monuments to Traces: Artifacts of German Memory, 1870-1990*, 30 which emphasizes both German nineteenth century memorial erection in particular as well as a more general trend.
[1035] Daum, "*Wissenschaft* and Knowledge," 153. Vierhaus, "Einrichtungen Wissenschaftlicher Und Populärer Geschichtsforschung Im 19. Jahrhundert," 109.
[1036] Demandt, "Natur- Und Geschichtswissenschaft Im 19. Jahrhundert," 40 in which the fine arts generally, and architecture particularly, are singled out as using historical models and templates.

organized as well by other nations in international and other exhibitions, for example in Turin, London, Antwerp and Paris.)[1037] Furniture styles during the German Empire (until modernist influences entered in around the turn of the century) largely hearkened back to earlier historical styles. In fact, in 1876 a large exposition of applied art in Munich displayed not only these historically influenced new pieces but three thousand pieces of historical furniture and other objects, the latter subsumed under the rubric "Our Fathers' Works".[1038]

During Emperor Wilhelm II's reign, beginning in 1888, the German court markedly increased its resort to historical and commemorative festivities. This was in part a reflection of this emperor's love of ceremony, but it also was intended to serve a political purpose—to demonstrate to the German people their past, although the kind of dynastic commemoration favored by the court was bound to leave many Germans cold. Accordingly, the Social Democratic party gave rein to a commemorative impulse too, although very different from the court or the bourgeoisie in what it honored.[1039] Figures of the workers' movement, and events marking its progress, were the subjects of German workers' parades.

THE GERMAN ARCHAEOLOGICAL ENTERPRISE

As part of the turn to history, interested individuals and groups in the German lands supported archaeological excavations.[1040] Antiquity carried an allure, and particularly Roman

[1037] Witt, "Naturwissenschaftlich-Technische Ausstellungen," 425. Franz Reuleaux, "Ausstellungswesen 1851-1899," in *Das Xix. Jahrhundert in Wort Und Bild: Politische Und Kultur-Geschichte*, ed. Hans Kraemer and Wilhelm Cahn (Berlin: Deutsches Verlagshaus Bong, 1900), 194-95.
[1038] Matthew Jefferies, "Imperial Germany: Cultural and Intellectual Trends," in *Nineteenth-Century Germany: Politics, Culture, and Society 1780-1918*, ed. John Breuilly (London: Arnold, 2001), 234.
[1039] Glaser, *Bildungsbürgertum Und Nationalismus: Politik Und Kultur Im Wilhelminischen Deutschland*, 115.
[1040] Böhner, "Altertumssammlungen Des 18. Und 19. Jahrhundert Im Rheinland," 66, 68, 70.

antiquity, due to the Roman Empire's extension into the German lands. In 1823 a collection of Roman antiquities was formed in Augsburg, followed by other such collections in several places in the southern German lands.[1041] The German archaeologists began to impress the scholarly world with their skillfulness.[1042] In 1829 the private Institute for Archaeological Correspondence launched itself in Rome. By 1832 already the Prussian state began financial contributions to it, finally becoming its sole support in 1859.[1043] Beginning in 1853, there were German efforts to initiate the excavation of the Greek site of Olympia in a cooperation with the Greek government, finally getting underway in 1874.

Patriotic impulses had a marked bearing on the archaeological activities. As the political impetus towards unification sharpened, an understanding grew of Roman and Middle-Ages artifacts found in German lands as "deutsch", that is, as belonging to a common German proto-national culture, rather than as restricted to the past of a particular dynasty, lineage or region.[1044] These ancient artifacts could be considered the heritage of all Germans; history was being invoked in the service of the national idea, just as science and history of science were. The nineteenth century stood out as the greatest era yet of the preservation and registration of relics in the German lands.[1045]

Increasingly there was a trend toward the historical exploitation of archaeological resources, rather than simply the accumulation of artifacts.[1046] In order to facilitate comparative work, to overcome the limitation of research devoted by societies to a given geographical

[1041] Spies, "Die Kunst- Und Kulturgeschichtlichen Lokal- Und Regionalmuseen: Zeiten, Auslosenden Faktoren, Initiatoren Der Gründungen," 78.
[1042] Marchand, *Down from Olympus: Archaeology and Philhellenism in Germany, 1750-1970*, 77.
[1043] Daum, "*Wissenschaft* and Knowledge," 154.
[1044] Böhner, "Altertumssammlungen Des 18. Und 19. Jahrhundert Im Rheinland," 68.
[1045] Schnabel, *Die Historische Kommission Bei Der Bayerischen Akademie Der Wissenschaften, 1858-1958*, 35.
[1046] Böhner, "Altertumssammlungen Des 18. Und 19. Jahrhundert Im Rheinland," 70, 74.

location, and to give an expression to the patriotic enthusiasm for a (future) unified fatherland, a combined German Historical and Antiquities Studies Association formed in 1852.[1047] At the head of this initiative was Hans von und zu Aufsess, the nobleman who also founded the German National Museum at this time. Aufsess had first made an attempt to unite German historical societies into one large framework in 1832, but found a readier response twenty years later.[1048]

After the founding of the German Empire, state resources were dedicated to rendering treasures and relics from the past accessible to the interested public. It became a prescribed part of what the state did. A commentor in the 1880s stressed that the Imperial and Prussian governments, "through acquisitions, archaeological excavations, and museum buildings, 'viewed it as its high cultural task to make available the assembled treasures for free study and for unlimited enjoyment to everyone, whatever nation he might belong to, in worthy buildings, in proud palaces.'"[1049] Just as science as practiced by the Germans contributed to firming the national sense of self, so did history, along with the related discipline of archaeology.

During the Empire, German public opinion could be roused to the notion that it was befitting their nation, successful in war and statecraft, to undertake cultural projects to the further enhancement of the nation's prestige. This was an argument that garnered legislative support for funding of the Olympia archaeological project in Greece.[1050] German scholars also participated in other nineteenth century archaeological undertakings, such as in Egypt, some among them shedding surprising new light on the sciences of long-past cultures.

The historical impulse was strong in the German lands throughout pre-unification decades

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[1047] Ibid., 71, 74.
[1048] Jürgen Voss, "Akademien, Gelehrte Gesellschaften Und Wissenschaftliche Vereine in Deutschland, 1750-1850," in *Sociabilité Et Société Bourgeoise En France, En Allemagne Et En Suisse, 1750-1850*, ed. Etienne François (Paris: Editions Recherche sur les Civilisations, 1986), 162.
[1049] Wolfgang Freiherr von Löhneysen and Hans Joachim Schoeps, *Kunst Und Kunstgeschmack Von Der Reichsgründung Bis Zur Jahrhundertwende* (Stuttgart: E. Klett, 1967), 89.
[1050] Marchand, *Down from Olympus: Archaeology and Philhellenism in Germany, 1750-1970*, 84-85.

and during the German Empire. It is no exaggeration to say that, just as an acclaim for science was a necessary precondition for the emergence of so much attention to the history of science in the period of the Empire, a preoccupation there with the historical dimension of many aspects of life and culture played a key role in Germany's bringing about (proto-) institutionalization of the history of science.

CONCLUSION

A variety of initiatives in researching, celebrating and collecting artifacts from historical events and eras were a driving force in Germany during most of the nineteenth century. The sheer number of the avenues along which history exerted a fascination on the nineteenth century Germans indicates that this fascination was deeply rooted and general. In this chapter a number of these avenues have been charted.

I have proposed that the scholarly research and the other manifestations of the history of science late in this period took their impulse from the more general historical turn evident in the German lands in the late eighteenth and early nineteenth century. The German-in-the-street, attuned to history in the many dimensions of life, and already primed to see the scientific achievements as characteristic of his nation, was increasingly now in a position to learn through multiple channels that the Germans could also be proud of a distinguished scientific tradition extending back centuries. By the final three decades of the century, along with the contribution of the contemporary scientific renown to German Imperial identity, the past scientific renown came to play a role in it.

The rise of science in Germany, and the prosecution of historical enterprises, were two essential ingredients in the launch of the German Empire historical scientific displays. Without

either, the displays would have been unlikely. Germany, smitten with science and history, joined the two to a degree that set it apart from other nations. In the years after the close of World War I and the dissolution of the Empire, despite the opening of the impressive new facilities for the Deutsches Museum in 1925, the German lead in the field, and pace-setting inquiry into science's material culture, was being challenged. Symptomatic of the increasing influence of the United States and other nations besides Germany in the field was the relocation of the important new history of science journal *Isis* to the United States from Belgium in 1919, as well as the location of the first two (1929 and 1931) international congresses exclusively devoted to the history of science at Paris and London.

Despite the curtailment of much of its momentum in furthering the field of the history of science with the coming of the First World War, we must acknowledge that Germany had done significant work in institutionalizing the history of science prior to that juncture. The Germans had shown a particular commitment to introducing this new field along a variety of dimensions during the period of their Empire. Given the importance by this juncture of science in society and world affairs, Germany seized on the opportunity to introduce the history of science to more Germans, and to emphasize the long-standing German eminence in science.

DISSERTATION CONCLUSION

This conclusion seeks to recapitulate the main body of the dissertation text and to comment generally on the phenomenon of the increased interest in the history of science and its manifestation in displays during the German Empire. Despite the perception of the ever-hastening modern advance of science, particularly in Germany during the Empire, the history of science enjoyed more suitable conditions for its expression and diffusion than at any prior time and place. Four factors were noted in the introduction. The surge in German scientific activity, in terms of both the scale of published work and in the number of active practitioners promoting it, and a pronounced German involvement at many levels with history in the period considered, were two of the factors. The nineteenth century has as well been described as the century of nationalism and as the century of bourgeois society. These attributions in their relationship to German history of the period together help explain the German precedence in the history of science's early institutionalization.

Taking historical scientific exhibitions as one key aspect of the activities commemorating the history of science during the German Empire, I have made the case that the history of science's early institutionalization should be ascribed foremost to Germans. Along with some practitioners, German Empire display organizers were involved in a new push to trace the long arc of science's development, to learn lessons from its past, and perhaps to offset the ceaseless acceleration of science with a counterforce of unhurried contemplation. Such activity was consistent with the cherished notion of the German lands as a site of deep thinkers. "The deep inwardness…of the German people's entire intellectual life, and its limitless push for freedom…are traits, which after upraising schooling of the intellect amount to a distinguishing

characteristic in the realm of scientific learning (*Wissenschaft*)" as well as in literature, wrote Paul Lorentz, one of the chapter authors in the commemorative book *Germany as World Power*, in 1911.[1051]

I have attempted through the use of primary sources to detail those events at which the history of science was displayed, offering to the public a chance to view the instruments, publications, manuscripts, maps, graphics, and sometimes personal effects of past science, and to give specifics on these events. I have further attempted to provide an in-depth depiction of the context which enabled and supported these and other events relating to the history of science's early institutionalization. These included both the most consequential political developments of the nineteenth century German lands, at the crux of which were the onslaught and defeat of Napoleon together with German unification in 1871, and the German industrial development, which helped provide the state coffers that were drawn on in supporting science.

Germans had arguably been the world's preeminent scientific people for two or more decades when German physiologist Emil du Bois-Reymond delivered a speech titled "Cultural History and Natural Science" before a learned society in Cologne in 1877. Du Bois-Reymond's position as a leading German scientist gave his comments particular force.[1052] The speaker differentiated between conventional history and what he considered an alternate, more pertinent plumb-line of history. Human history as commonly recited was an unedifying cycle of greed,

[1051] Lorentz, "Die Deutsche Wissenschaft," 440.
[1052] Du Bois-Reymond, DuBois-Reymond, and Rosenthal, *Reden Mit Einer Gedächtnisrede Von Julius Rosenthal*, 567-629. See also 621, footnote 1, which specifies that the text of the speech was printed in short order three times in Germany, as well as in France and the United States. For an earlier speech by du Bois-Reymond with related coverage, see *Reden Mit Einer Gedächtnisrede Von Julius Rosenthal*, 431-40; See also Gunter Mann, "Geschichte Als Wissenschaft Und Wissenschaftsgeschichte Bei Du Bois-Reymond " *Historische Zeitschrift* 231, no. 1 (1980). Christoph Gradmann, "Naturwissenschaft, Kulturgeschichte, Und Bildungsbegriff Bei Emil Du Bois-Reymond," *Tractrix* 5 (1993): 4.

treachery, and revenge: indeed, much of the world's history had been a repetitive morass.[1053]

The alternative history he proposed, in which human reason prevailed, was based on the development of *natural* understanding. It underwent its chief caesura with the onset of the age of natural science in the seventeenth century. Du Bois-Reymond heralded the breakthrough in human history represented by the advent of a natural scientific, experimental approach, which began what he called "the technical-inductive era".

In contradiction to a narrative of self-serving, cyclical *in*humanity, du Bois-Reymond posited that what really made a human [*der Mensch*] a human was his capacity for thoughtful reflection on his surroundings and his aspiration to improve his material circumstances. Only with the coming of physical insight was the inalterable advance of human history assured, and it was in the increasing reach of this insight that the advance could be measured. Beginning with Galileo's mathematical derivation of physical relationships, du Bois-Reymond located a progressive improvement of humankind's existence. "We say, natural science is the outright agency of culture, and the history of natural science is the true history of humankind."[1054]

Du Bois-Reymond argued in his 1877 speech:

> Doesn't [conventional] history teach us only that man learns nothing through it? Has mankind advanced, until the onset of the current [technical-inductive] period, to higher levels of freedom, morality, power, art, well-being and knowledge?...But...who can blame the small band who view as the true history of the human species those things which, alongside all of what consists of life's vagaries, cruelties and delusions, present to us for inspection its gradual elevation from half-animality, its progress in arts and learning, its increasing mastery over nature, its daily increasing prosperity, its freeing from the shackles of superstition, in short, its continual approach to the aims which make men men.[1055]

[1053] Du Bois-Reymond, DuBois-Reymond, and Rosenthal, *Reden Mit Einer Gedächtnisrede Von Julius Rosenthal*, 593-95.
[1054] Ibid., 596.
[1055] Ibid., 594.

He further argued that, in future times, such was the importance of the coming of scientific reason to humankind, it would be taken as on a par with the significance to history of the coming of monotheism![1056] For a century, and a nation, in which science impacted life on the everyday and the global levels, du Bois-Reymond's centering of history on natural science scarcely seemed exaggerated. Together with its consort technology, science was a source of great material power. Insofar as it was useful in national assertion, the history of science was assured a modicum of influence. Correspondingly, a gathering interest in the history of technology was brought about, late in the German Empire, by "nostalgia and the search for identity in a time of [scientific-technical] upheaval."[1057] The rise of bourgeois society also favored the development of science (nineteenth century scientists generally, particularly in Germany, forming part of the *Bildungsbürgertum*) and the development of the exhibition culture that were preconditions for the history of science displays. In an era when progress was the general darling, science was seen to embody it more than any other sphere of human involvement.[1058] And German lands, ahead of the founding of the Empire in 1871, had become *par excellence* the loci of scientific eminence.

In du Bois-Reymond's remarks, the German preoccupation with studying the course of history additionally comes through. In the nineteenth century, the Germans were a people entranced not only by science, but also by history. Gabriel Finkelstein, in a chapter in his du Bois-Reymond biography treating the Cologne speech in fine detail, judges that it provided the first programmatic statement in some time in Germany on the mission of the discipline of

[1056] Ibid., 598.
[1057] Ulrich Linse, "Die Entdeckung Der Technischen Denkmäler. Über Die Anfange Der "Industriearchäologie" In Deutschland," *Technikgeschichte* 53, no. 3 (1986): 217.
[1058] Laudan, "Histories of the Sciences and Their Uses: A Review to 1913," 22 footnote 3.

history.[1059]

Du Bois-Reymond went further: "Only in the investigation of nature [*Naturforschung*] and its mastery is there no stagnancy [*Stillstand*], while [humankind's] estate [*Besitz*] continually increases, and creative power goes on begetting in unending succession. Only in these [enterprises] stands each new generation solidly on the shoulders of its predecessor."[1060] With these words, he gave passionate voice to an assessment of history no doubt cordial to many of the practitioners of science, in Germany and elsewhere. Indeed, he elevated the advent of a scientifically reasoning age as nearly equal in nobility to, and patently more lasting than, that of Greek antiquity.[1061]

Du Bois-Reymond's emphasis on a version of the history of humankind, told in terms of its idealistic advances in natural knowledge that also served to harness nature, sets the ground for a German enterprise, largely bourgeois in its conduct, that was underway in the exact time that he spoke: to bring the history of science in front of the German people, and to begin its institutionalization. The speaker was in fact spelling out developments in the history of science that would characterize the whole period of the German Empire:

> As slight as the human race appears from an Archimedean perspective, so much the greater seem now its achievements vis-à-vis Nature, so much more worthwhile its striving in her service, so much more compelling the history of the traits of her intellectual conquest. Just as this history has other days of remembrance and other holy sites than civil [*bürgerliche*] history, so certainly are also its kings and heroes others...[1062]

Although most Germans who participated in dilating the history of science awareness

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[1059] Finkelstein, *Emil Du Bois-Reymond: Neuroscience, Self, and Society in Nineteenth-Century Germany*, 229. Christoph Gradmann, in a piece written earlier, challenges this view that the printed editions of du Bois-Reymond's speech had significant influence on subsequent cultural history. Gradmann, "Naturwissenschaft, Kulturgeschichte, Und Bildungsbegriff Bei Emil Du Bois-Reymond," 9.
[1060] Du Bois-Reymond, DuBois-Reymond, and Rosenthal, *Reden Mit Einer Gedächtnisrede Von Julius Rosenthal*, 600.
[1061] Ibid., 593.
[1062] Ibid., 596.

during the Empire did not aim to overturn or displace the reign of conventional history as du Bois-Reymond had suggested, they certainly did advance an image of scientists as societal heroes, selfless and impassioned, idealistic and daring, rational and motivated. One prominent figure who did subscribe in full to the perspective upheld by du Bois-Reymond was "the father of the history of science", the Belgian-national (who would become an American citizen) George Sarton. In his statement introducing the field of the history of science in the first issue of *Isis* in 1913, Sarton advocated that "perhaps [the field of the history of science] will one day become the central element of the history of civilization, around which all the other elements will collect to explain it and more strongly give it force."[1063]

During the German Empire, those who accorded science a central place in contemporary society and in history were on the increase. The considerable level of apotheosis of science and its practitioners accompanied the nascent surge in the attention to the history of science. I have attempted to flesh out what some practitioners, publicists, and popularizers of science did to raise the profile of the history of science as a productive and constructive force in German life. The focus on exhibitions and displays has allowed me to narrow down the larger phenomenon to isolate in some detail how Germans were engaging in this new field.

One of my main intents for the dissertation has been to render clear the close ties between the German sense of a tradition of scientific excellence and national pride. We get a taste of possible chauvinistic motivations for the organizers of historic scientific displays in a written exclamation of Max Hirsch in 1905. He said that the Medico-Historical Cabinet at the Germanisches Nationalmuseum should be developed further into a museum of healing arts, so that the entire German nation, which was now also in first place in medicine, could feel proud of

[1063] Sarton, "L'histoire De La Science," 16.

it.[1064] And co-organizer of the 1898 Düsseldorf exhibition Karl von Sudhoff's remark about the Deutsches Museum has some of the same bombastic thrust, when he characterized its "continual chorus of becoming, developing and perfecting and again acting, which resounds with a rumble in the life of the peoples, the mighty chorus of creation, of work on all fronts."[1065]

At various displays, their German organizers straddled somewhat divergent positions regarding whether to center on German science or to be more inclusive. The apothecaries' exhibit of 1879 and the electricity expositions, like the historical scientific displays at the 1893 and 1904 world's fairs, were examples of displays that foregrounded specifically Germanic scientific contributions. A broader take on the narrative of the development of science, incorporating more non-Germanic contributions, held at the mathematical exhibition of 1893, the 1884 and 1899 Bavarian Royal Court- and Realm-library exhibitions of geography and medical manuscripts, respectively, the Deutsches Museum, and the international flight exhibition of 1909. The 1898 Düsseldorf display at the German Scientists and Physicians meeting also had a broader international and multi-cultural scope but may have indicated a tendency to favor Germanic science by its inclusion of original Roman (as part of Germanic history) medical implements without an equal attention to those of ancient Greece.

Was Germany during the Empire in any instance more interested in telling the overall narrative of the history of science than in highlighting specifically German scientific achievements? The two positions are actually difficult to cleanly separate, as the rhetoric and the practice at the Deutsches Museum illustrates. Walther von Dyck's remarks on the Deutsches Museum in 1903 presenting the museum as a national, "German", institution and Oskar von

[1064] Hirsch, "Das Medico-Historische Kabinett Im Germanischen Nationalmuseum Zu Nürnberg."
[1065] Sudhoff, "Zur Grundsteinlegung Des Deutschen Museums Von Meisterwerken Der Naturwissenschaft Und Technik Am 13. Nov. 1906," 2250.

Miller's reminder in 1929 that the museum should be regarded as a place for the whole German people both suggest that the museum's two principal directors were trying to emphasize the German scientific achievements. Yet, in practice the museum, with its inclusion of numerous artifacts and relics from the composite development of science, also aspired to tell the story of science generally. The apparent contradiction can be moderated by a recognition that the German precedence in contemporary science was always a feature of the German Empire public consciousness. Telling a composite story of the development of science, including non-Germanic science, was natural given the great significance that science had currently assumed in the world. A narrative of composite past science in the years of the Empire could contribute to fully comprehending the rise to centrality of science in modern society. The great modern significance of science itself lent magnificence to Germany, which its citizens felt was singular in the dominance it had taken within late nineteenth century science. Further explaining the disposition of non-Germanic relics, in cases where these were included in historical scientific displays organized by Germans, was the fact that in almost every display, Germanic relics were still preponderant, which, suggesting the high level of past Germanic scientific achievement, would have served to heighten the sense of national roots and of national pride.

I make the argument that another of the purposes or functions of displays was to bridge differences and divisions among the German people. The argument is put forward based on the fact that these divisions existed and were potentially sources of disaffection for the nation. The history of science could play a part in overcoming isolation or division, just as the existence of a national institution such as the Deutsches Museum that many Germans had contributed to also helped to solidify a corporate national identity.[1066]

[1066] Dyck, *Über Die Errichtung Eines Museums Von Meisterwerken Der Naturwissenschaft Und Technik in München*, 23. Miller, *Technische Museen Als Stätten Der Volksbelehrung*.

I have asserted the influence of the 1876 London scientific exhibition on what came afterwards. An argument for this based on the great scope of that exhibition has been made at the appropriate place. It could not fail, by its size, to register at home and abroad that science and its history were worthy of display. Also, prodded by the British to participate, the Germans exerted themselves admirably in the 1876 event and thus set a precedent for their future involvement in scientific display. But past 1876, the Germans got busy and led the way for decades in displaying the history of science.

We can't say whether Germany would have been responsible for more of the subsequent institutionalization of the history of science if world war had not intervened and led to a German disarray and impoverishment, not to mention its pariah status in international scholarship for a period of a few years. I believe that the signs favor a hypothetical German leadership in the history of science had there been no world war, but all that is certain is that the German lead in proto-institutionalization of the discipline did not seamlessly progress on to leadership in its subsequent full institutionalization after the end of the First World War. There was substantial activity in science history in Germany during the Weimar years, but the country was no longer operating at the forefront, able to exercise a determinative influence, and for some years, its achievements took place in the scholarly isolation to which Germany was condemned by the victorious allies.

It is hoped that the work undertaken here will alleviate somewhat the prior lack of historiographical attention to this area. Few books or articles sufficiently recognize the early German scholarship and the other early contributions made to the discipline by the Germans. For example, in *Making Modern Science: a historical survey*, Peter Bowler and Iwan Morus trace the *institutionalization* of the discipline to the period around the end of the Second World War, when

it "began to achieve recognition as a distinct academic specialization"—in places other than Germany.[1067] Rachel Laudan, writing on histories of science prior to 1913, devotes all her attention to the books treating the advent of science generally or those charting specific disciplinary histories. As such, her account makes little of Germans' work in the field during the Empire.[1068]

The evidence assembled in this dissertation underlines the connection between a rise in the social import of science and technology, an increase in the numbers of scientists, a high level in the nineteenth century of the attention to history generally, the ongoing influence of the bourgeoisie in German public life during the Empire, the value to the new nation of establishing firmer ties among its citizens based on "invented traditions", and the increased attention to science's history, including displays, taking place towards the end of the nineteenth century. Given that the precipitants of these developments were present during the German Empire to a degree more marked than anywhere else in that period, it is understandable that the discipline of the history of science set down roots so prominently in Germany. The historical scientific displays were one of the primary areas of attention to the history of science in which Empire Germans outdid the nationals of other states. While no German site hosted a "universal" world's fair in the nineteenth or early twentieth century, there was a significant German Empire activity in other kinds of display. It is not surprising, then, that such German exhibition organizing extended to scientific relics during the Empire period. Hopefully yielding insights into how all these elements interconnected, this investigation both aims to fill a gap in the historiography of the history of science and of German nation-building and to stimulate further interest in the origins of our more recent fascination with the history of science.

[1067] Bowler and Morus, *Making Modern Science: A Historical Survey*, 6.
[1068] Laudan, "Histories of the Sciences and Their Uses: A Review to 1913."

Deutsche Unterrichtsausstellung auf der Galerie des Industriegebäudes.
Mathematik und Physik in der Universitätsausstellung.

Figure 1: **World's Fair Deutsche Unterrichtsausstellung** auf der Galerie des Industriegebaüdes –
Mathematik und Physik in der Universitatsaustellung (*Amtlicher Bericht* volume 2 Chicago, 1893) (German Education Exhibition in the Industry Building Gallery – Mathematics and Physics in the University Display) page 995.

Figure 2: Rooms of the historical division of the first **International Air Transport Exhibition** in Frankfurt am Main 1909, frontispiece of the *Katalog der historischen Abteilung der ersten internationalen Luftschiffahrts-Ausstellung (ILA) zu Frankfurt am Main*.

Fig. 15. Historische Apotheke im Germanischen Nationalmuseum.

Figure 3: **German National Museum Historical Apothecary's Office -** *Mitteilungen aus dem Germanischen Nationalmuseum* 1913 page 64.

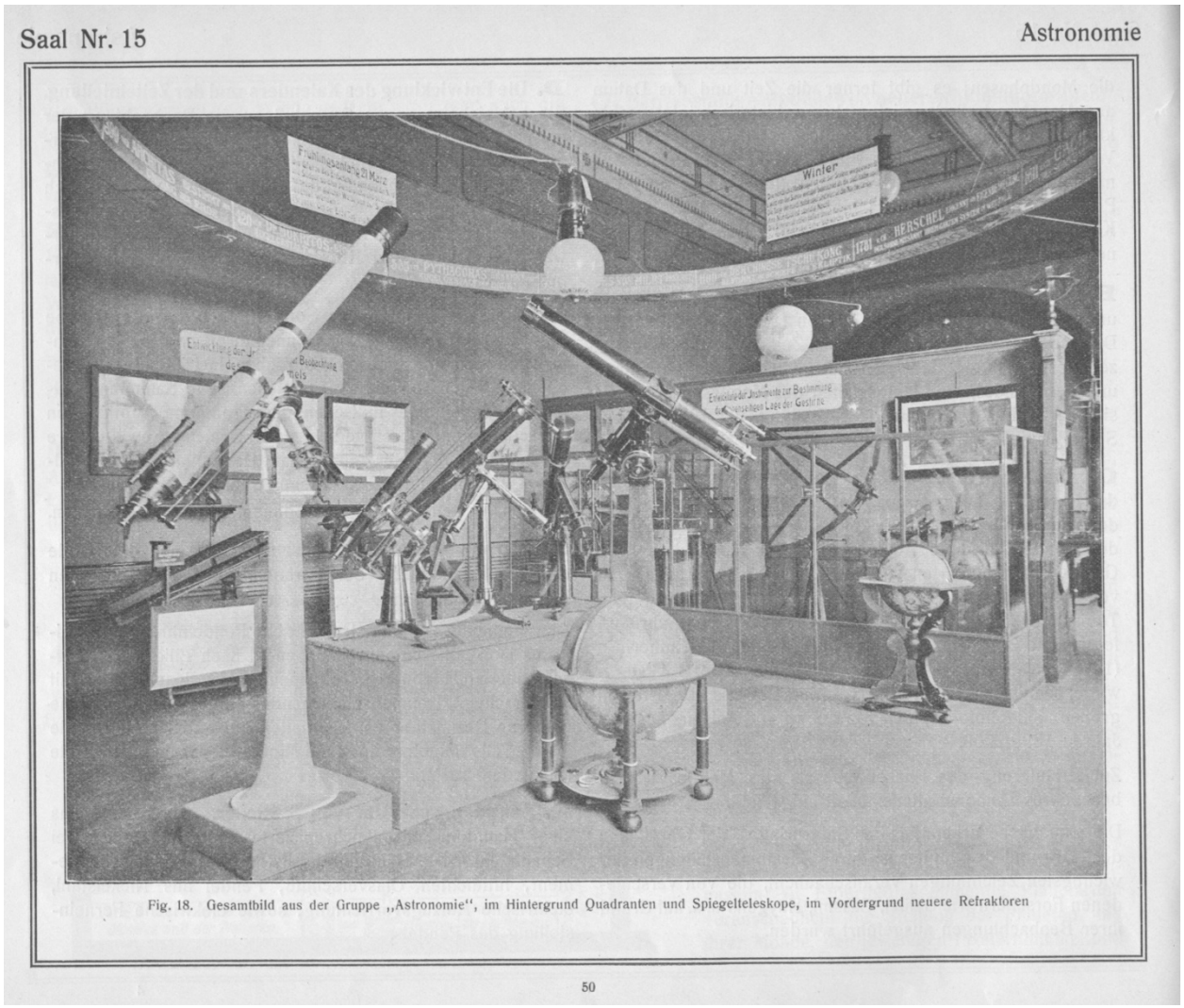

Figure 4: Overall view of the **Deutsches Museum Astronomy Group**, with quadrants and mirror telescopes in the background, newer refracting telescopes in the foreground – Deutsches Museum *Führer* 1906 page 5.

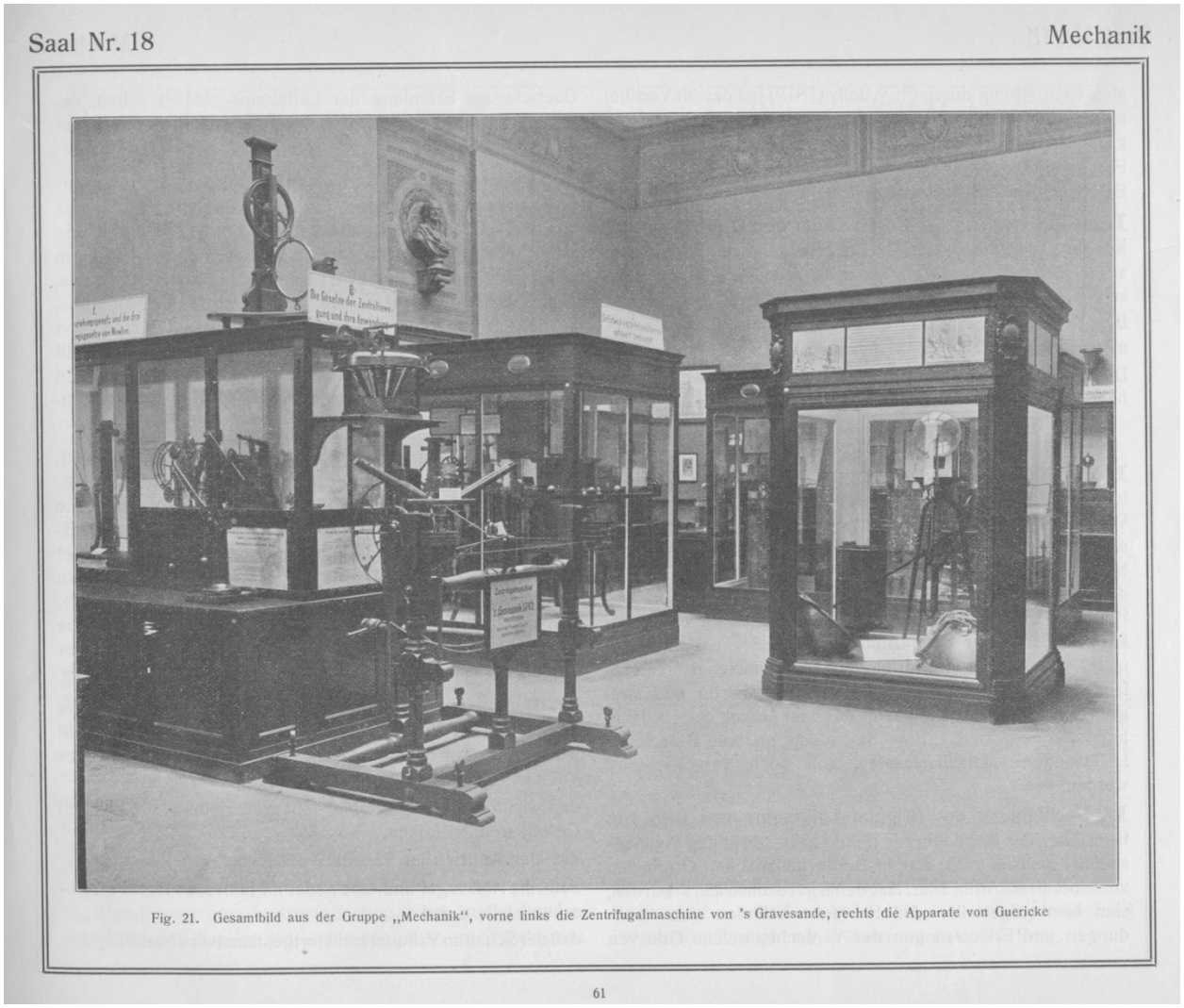

Figure 5: Overall view of the **Deutsches Museum Mechanics Group**, on the left front the centrifugal machine of 's Gravesande, on the right von Guericke's vacuum apparatus – Deutsches Museum *Führer* 1906 page 66.

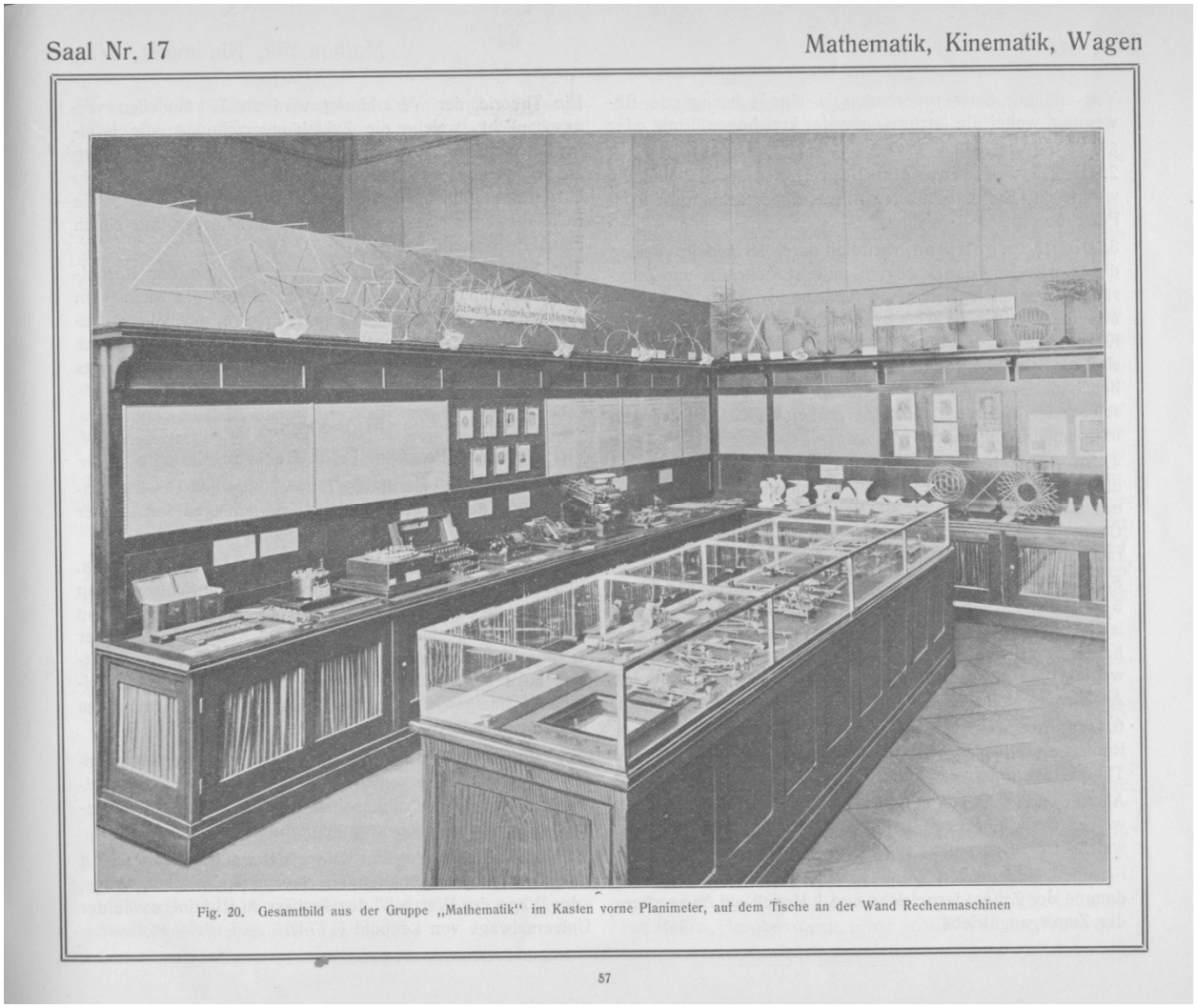

Figure 6: Overall view of the **Deutsches Museum Mathematics Group**, in the cabinet in the front planimeter, on the desk along the side wall calculating machines, on the desk along the back wall calculators – Deutsches Museum *Führer* 1906 page 62.

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