Technik Comes to America

Changing Meanings of *Technology* before 1930

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Anglo-American historians of technology have been remarkably incurious about *technology*, the most central term in the field.[1] To a great extent, this neglect has been remedied by Ruth Oldenziel, Leo Marx, and Ron Kline, whose work suggests that the meanings now attached to the word in current American discourse are of relatively recent origin. Oldenziel and Marx in fact argue that it attained the status of "keyword" only in the 1930s, and that before this time, issues that historians now discuss in terms of *technology* were framed in such terms as *useful arts*, *manufacturing*, *industry*, *invention*, *applied science*, and *the machine*. In other words, when historians now address "attitudes toward technology" before 1930, they are employing an analyst's category not used by the historical actors themselves.[2]

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1. In this article, I use the convention of italicizing words when referring specifically to the term itself, rather than its referent. On the lack of curiosity about *technology*, see the early volumes of *Technology and Culture*, which contain many discussions of the meaning of *technology*, but nothing of substance on the concept's history: for example, Melvin Kranzberg, "At the Start," *Technology and Culture* 1 (1960): 1–10; Peter Drucker, "Work and Tools," *Technology and Culture* 1 (1960): 28–37; Robert P. Multhauf, "The Scientist and the 'Improver' of Technology," *Technology and Culture* 1 (1960): 38–47.

2. Ruth Oldenziel, *Making Technology Masculine: Men, Women, and Modern Machines in America, 1870–1945* (Amsterdam, 1999), especially chap. 1, "Unsettled Discourses"; Ruth Oldenziel, "Gender and the Meanings of Technology: Engineering in the U.S., 1880–1945" (Ph.D. diss., Yale University, 1992), chap. 2; Leo Marx, "The Idea of 'Technology' and Postmodern Pessimism," in *Does Technology Drive History?* ed. Merritt

When the term did become widespread in elite discourse in the United States, it bore the stamp of a long struggle over the meanings of industrialization. According to Marx, *technology* helped raise the *useful arts* above the world of grubby artisans and into the spheres of big business and the university. Similarly, Oldenziel views the present-day meanings of *technology* as the product of a class and gender struggle in which middle-class male engineers became the principal avatars of *technology*. Kline demonstrates that the term incorporated much of the prior discourse of *applied science*.[3] Taken together, the work of these scholars complicates not only the early twentieth-century meanings of *technology*, but also its current use.

Despite these pathbreaking histories of the discourse of *technology*, a central question remains unanswered: Precisely when and how did *technology* assume the meanings that have brought it from obscurity to keyword? I argue that this semantic shift took form during the early decades of the twentieth century. I also argue that these new meanings derived primarily from the writings of American social scientists who imported elements of the German discourse of *Technik* into the English term *technology*, thus shifting the latter from its original definition as the science or study of the useful arts to a new one that embraced the industrial arts as a whole, including the material means of production.[4]

In nineteenth-century English, *technology* was a somewhat specialized term sharing a common set of meanings with its cognates in French and German. These meanings centered on *technology* as a field of study concerned with the practical arts; except in anomalous usage, they did not refer to industrial processes or artifacts. In German-speaking regions, a new discourse emerged around *die Technik* in the second half of the nineteenth century, which referred to the practical arts as a whole, especially those associated with engineers and modern industry. When Thorstein Veblen encountered the concept of *Technik* in German social theory, he incorporated its meanings into the English word *technology*, thereby transforming it into a sophisticated concept that was in many ways ahead of its time. Most scholars who drew on Veblen's concept missed its subtleties, however,

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Roe Smith and Leo Marx (Cambridge, Mass., 1994), 238–57; Leo Marx, "*Technology*: The Emergence of a Hazardous Concept," *Social Research* 64 (1997): 965–88; Ronald Kline, "Construing 'Technology' as 'Applied Science': Public Rhetoric of Scientists and Engineers in the United States, 1880–1945," *Isis* 86 (1995): 194–221.

3. Marx, "*Technology*," 978; Oldenziel, *Making Technology Masculine*, especially 14–16, 45, 49–50, and 182–88; Kline, "Construing 'Technology' as 'Applied Science,'" 217–18.

4. Mikael Hård has suggested to me that this process is comparable to the idea of the "intellectual appropriation of technology" that he developed with Andrew Jamison to explain changing ideas about technology across national contexts. Mikael Hård and Andrew Jamison, "Conceptual Framework: Technology Debates as Appropriation Processes," in *The Intellectual Appropriation of Technology: Discourses on Modernity, 1900–1939*, ed. Mikael Hård and Andrew Jamison (Cambridge, Mass., 1998), 15.

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and, like the historian Charles A. Beard in the late 1920s, instead embraced a deterministic understanding that linked *technology* firmly to the idea of progress. The evolution of the current meanings of the term has thus been subject to the struggle between deterministic and nondeterministic interpretations of *technology*.

My analysis is necessarily limited. I focus on the scholarly use of a single term, primarily within the social sciences. A more complete study would follow Ruth Oldenziel's example and consider the full range of terms—such as *the machine* and *science*—that were used to discuss the material culture of modernity. Such an analysis would move beyond academic studies to examine the various discourses that arose around the problems and promise of industrial civilization, especially the discourse of engineers. A fuller examination would also reveal that the discourse of *Technik* continued to shape the meanings of *technology* through multiple paths, well into the 1960s.[5]

The Meaning of *Technology* in Nineteenth-Century Europe and America

One of the enduring puzzles about *technology* is the divergence in terminology between English and the Continental languages, an issue long acknowledged by European scholars.[6] Whereas a single term seems adequate in English, Continental languages use two, the cognates of *technique* and *technology*. The distinction is relatively clear: *technique* refers to the

5. Oldenziel, *Making Technology Masculine*, chap. 1. Methodologically, my analysis draws on the well-worn maxims of intellectual history after the linguistic turn. Most importantly, I posit no "essence" to the concept of technology that historians can trace through changing terminology across time and languages. In Foucault's formulation, I seek the genealogy of *technology*, not its origins. Unlike Foucault, I focus not on discourse but on one "keyword," extending Oldenziel's analysis of *technology* inspired by the work of Raymond Williams. But my approach more closely echoes the German history of concepts, *Begriffsgeschichte*, in my contextual analysis of a specific term through time. In particular, I take seriously the simultaneous distorting and enabling effect that current meanings have on our understanding of past concepts. This problem is especially pregnant for *technology*, a term whose powerful present-day meanings hang like dead weight on our understanding of the past. Michel Foucault, "Nietzsche, Genealogy, History," in *The Foucault Reader*, ed. Paul Rabinow (New York, 1984), 97–100; Raymond Williams, *Keywords*, 2nd ed. (London, 1983), 11–25; Melvin Richter, "Reconstructing the History of Political Languages: Pocock, Skinner, and the *Geschichtliche Grundbegriffe*," *History and Theory* 29 (1990): 38–70.

6. See Pietro Redondi, "History and Technology: Research on the Borderline," *History and Technology* 1 (1983–84): 1–6; Jean Sebestik, "The Rise of Technological Science," *History and Technology* 1 (1983–84): 25–26; Jean-Jacques Salomon, "What Is Technology? The Issue of Its Origins and Definitions," *History and Technology* 1 (1983–84): 113–16; Guido Frison, "Linnaeus, Beckmann, Marx, and the Foundation of Technology," pt. 1, *History and Technology* 10 (1993): 139–40.

methods and procedures of material culture, especially in engineering and industry, while *technology* is concerned with the study of these activities, their principles. That both terms are generally translated as *technology* in English causes an important distinction to be lost.[7]

The divergence between English and Continental usage did not exist in the nineteenth century when, for the most part, English, French, and German recognized a common set of meanings for *technology*. This commonality is apparent in both dictionary definitions and actual usage. Although extensively developed in German, the concept was unusual in English until the founding of the Massachusetts Institute of Technology (MIT) in 1861. Even then, the scope of *technology* in English was largely limited to technical education, and was little used, for example, in the social sciences that were emerging in late-nineteenth-century America. Overall, then, the now-dominant meanings of *technology* simply did not exist during the nineteenth century.

The term *technology* in nineteenth-century English, French, and German was derived from seventeenth- and eighteenth-century Latin—a heritage common to the educated elites of both Europe and its colonies. The modern Latin term *technologia* had three general meanings, all based on the word's Greek etymology, which combined *logos* (discourse) with *tekhne* (skill or art): 1) the arts of language—that is, grammar; 2) the discourse or description of the arts; and 3) the terminology of a particular art or the arts in general (as used here, *art* includes both the fine and mechanical arts). These meanings carried over to the vernacular, although the first definition (grammar) largely disappeared during the nineteenth century.[8] By the nineteenth century, *technology* in English, French, and German referred to the description, principles, or teaching of the practical arts and, less often, to technical terminology. In this usage, *technology* was a field of study, not the object of study.

Dictionaries and encyclopedias in English, French, and German were in agreement on this general meaning. George Crabb's *Universal Technological*

7. *Historisches Wörterbuch der Philosophie*, vol. 10 (Basel, 1998), 946–50, 958–59; Günter Ropohl, "La signification des concepts de 'technique' et 'technologie' dans la langue allemande," in *De la technique à la technologie*, Cahiers S. T. S. (Paris, 1984), 23–29 (I thank Pap Ndiaye for this reference). Although European historians of technology have been influenced by English usage since the 1960s, *technique* remains dominant, as in the German *Technikgeschichte*, the French *l'histoire des techniques*, the Dutch *techniekgeschiedenis*, the Italian *storia della tecnica*, the Swedish *teknikhistoria*, and so on, but compare the Danish and Norwegian *teknologihistorie* (I thank Mikael Hård for signaling this last usage).

8. This analysis is drawn from Wilfried Seibicke, *Technik: Versuch einer Geschichte der Wortfamilie um "techne" in Deutschland vom 16. Jahrhundert bis etwa 1830* (Düsseldorf, 1968), 96–119. See also Carl Mitcham, "Philosophy and the History of Technology," in *The History and Philosophy of Technology*, ed. George Bugliarello and Dean B. Doner (Urbana, Ill., 1979), 184, 192.

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Dictionary of 1823 defined *technology* as "a description of the arts, especially those which are mechanical." Similarly, an 1877 French dictionary defined *technologie* as: "1) Traité des arts général; 2) Explication des termes propres aux différents arts et métiers."[9] The 1854 *Brockhaus* encyclopedia defined *Technologie* as the "teaching [Lehre] of the arts," specifically their material aspects.[10]

Technology was also defined as the science of the practical arts, in the nineteenth-century meaning of science as organized knowledge. This definition had its roots in the work of Johann Beckmann, a professor at the University of Göttingen who published *Anleitung zur Technologie* in 1777. This work, which defined *technology* as "the science that teaches the processing of natural products or the knowledge of handicrafts," marked the beginning of *Technologie* as an academic field in German-speaking countries.[11]

Similar uses of *technology* can be found in the United Kingdom, the United States, and France. In his 1855 inaugural lecture as the first Regius Professor of Technology at Edinburgh University, George Wilson introduced *technology* as "the *Science of the Arts*, or, as generally restricted, the *Science of the Useful Arts*." Likewise, a late-nineteenth-century French encyclopedia defined "la technologie" as "la science des arts industriels, des métiers." In English, the definition of *technology* as the science of the arts persisted into the twentieth century. *The Century Dictionary*, published in New York in 1911, defined *technology* as "that branch of knowledge which deals with the various industrial arts; the science or systematic knowledge of the industrial arts and crafts, as in textile manufacture, metallurgy, etc."[12] Comparable definitions continue to be prominent in German and French.

These extracts suggest that the current characterization of *technology* as the methods and material equipment of the practical arts did not exist in

9. George Crabb, *Universal Technological Dictionary, or Familiar Explanation of the Terms Used in All Arts and Sciences, Containing Definitions Drawn from the Original Writers*, 2 vols. (London, 1823), s.v. "technology"; *Dictionnaire Littré*, vol. 7 (1877), as quoted in Jean-Claude Beaune, *La technologie introuvable* (Paris, 1980), 261. The *Oxford English Dictionary* provides comparable examples of early English usage.

10. *Brockhaus' Conversations-Lexikon*, 10th ed. (Leipzig, 1854), 14:719.

11. Johann Beckmann, *Anlietung zur Technologie* (1777), §12, quoted in "Définitions de la technologie," *Thalès* 12 (1966): 85; Frison, "Linnaeus, Beckmann, Marx, and the Foundation of Technology" (n. 6 above), 139–67. On Beckmann and his legacy, see *Technologie: Zwischen Fortschritt und Tradition: Beiträge zum Internationalen Johann Beckmann-Symposium, Göttingen 1989*, ed. Hans-Peter Müller and Ulrich Troitzsch (Frankfurt, 1992).

12. Review of George Wilson, "What Is Technology?—an Inaugural Lecture," *Canadian Journal of Industry, Science, and Art* 1 (1856): 53–58, quote on 54; *La grande encyclopédie, inventaire raisonné des sciences, des lettres et des arts* (Paris, 1886–1902), s.v. "Technologie"; *The Century Dictionary* (New York, 1911), s.v. "technology." On Wilson, see R. G. W. Anderson, "'What Is Technology': Education through Museums in the Mid-19th Century," *British Journal for the History of Science* 25 (1992): 169–84 (I thank David Edgerton for this reference).

nineteenth-century English. Differences between past and present definitions are all too easy to overlook, however; in context, both often make sense, *technology* being readily viewed both as the study of the object and as the object of study. In addition, some nineteenth-century authors carelessly applied the term to the industrial arts in general. The *Oxford English Dictionary* (*OED*) traces this use to the English explorer and anthropologist Richard F. Burton, citing his works of 1859 and 1864 as the earliest examples of *technology* being defined as "the practical arts collectively." But while *OED*'s editors may be correct with respect to the specific sources, such usage was nonetheless anomalous prior to the twentieth century.[13]

The tendency to project present-day meanings into the past is clear in the widely repeated claim that botanist and physician Jacob Bigelow introduced the present-day concept of *technology* into American usage in his *Elements of Technology* of 1829. As Oldenziel has argued, this claim is simply false. While Bigelow's book may have helped to familiarize Americans with the term, his usage was fully consistent with its nineteenth-century meanings. In his preface, Bigelow noted that his purpose was to collect scattered knowledge of relevance to the arts, and that he "adopted the general name of Technology" to encompass "an account . . . of the principles, processes, and nomenclatures of the more conspicuous arts, particularly those which involve applications of science, and which may be considered useful." In other words, Bigelow used *technology* to denote his *treatise* on the practical arts. The term was not used in the body of the text, and was even dropped from the title of the revised edition, which appeared as *The Useful Arts* in 1840.[14]

Rather than Bigelow's 1829 book, it was the founding of the Massachusetts Institute of Technology in 1861 that brought *technology* into more common usage in the United States. While the reasons behind the name of the institute remain obscure, it is possible that Bigelow helped influence

13. Oldenziel, *Making Technology Masculine* (n. 2 above), 14; *Oxford English Dictionary Online*, 2nd ed., s.v. "technology." The volume first containing this definition and the cited examples was published in 1919.

14. Oldenziel, *Making Technology Masculine*, 23; Jacob Bigelow, *Elements of Technology*, 2nd ed. (Boston, 1831), iv; Jacob Bigelow, *The Useful Arts, Considered in Connexion with the Applications of Science* (Boston, 1840). Contemporaries regarded Bigelow's title as odd. "Bigelow's *Elements of Technology*," *North American Review* 30 (April 1830): 337–38. Hugo Meier appears to be the first historian to suggest that *technology* "entered into popular usage" with the publication of Bigelow's book. Hugo A. Meier, "Technology and Democracy, 1800–1860," *Mississippi Valley Historical Review* 43 (1957): 618–19, 623; see also Howard P. Segal, *Technological Utopianism in American Culture*, 2nd ed. (Syracuse, 2005), 78–81. My view of Bigelow is informed by electronic databases of nineteenth-century sources unavailable to historians before the mid-1990s; these do not reveal an increased use of the term *technology* between 1829 and the founding of MIT. Although Bigelow cited no German sources, his work was similar to Beckmann's *Anleitung zur Technologie*.

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MIT founder William Barton Rogers to choose *technology* over *polytechnic*, which at the time was the standard term for a school of higher technical education. But even in the discourse surrounding the founding of MIT, *technology* remained peripheral; instead, this discourse was framed primarily in terms of *applied science* and the *arts*. After the founding of MIT and its imitators, *technology* became somewhat more common in American discourse, but mainly as a term for higher technical education.[15]

Despite the use of *technology* in, and for, higher technical education, the term was almost completely absent from Anglo-American social theory before 1900, nor was it used in classical British political economy, even when these works examined the economic significance of machinery. Anglo-American social scientists did not ignore the issues raised by rapid industrialization, but these dramatic changes were discussed in terms of *invention*, *industry*, *useful arts*, *machinery*, and *science*.[16]

While there were exceptions, these were both minor and fully consistent with the definition of *technology* as the study of the useful arts. The emerging discipline of anthropology devoted a great deal of attention to material culture among "primitive" peoples. In 1879, a group of prominent social scientists founded the Anthropological Society of Washington. The original constitution of the society specified four sections: archaeology, somatology, ethnology, and philology. In 1882, following discussions among the society's founders—John Wesley Powell, Garrick Mallory, and Otis T. Mason—the archaeology section was renamed "technology." The reasons for the change are unclear, but it is likely that the renamed section was to include studies of material culture among the living as well as the dead. In this context, therefore, *technology* clearly referred to a field of study within anthropology; indeed, Powell made this meaning explicit the following year when he declared that "the science of the arts is technology."[17]

The term did not gain currency in American anthropology before the 1930s, however. In his 1888 address as president of the Anthropological Society, Powell made the "arts" a key factor separating the grand cultural

15. *Objects and Plan of an Institute of Technology, Including a Society of Arts, a Museum of Arts, and a School of Industrial Science, Proposed to be Established in Boston* (Boston, 1860); William Barton Rogers, "A Plan for a Polytechnic School in Boston," in *Life and Letters of William Barton Rogers*, ed. Emma Rogers and William T. Sedgwick (Boston, 1896), 1:420–27; Julius Adams Stratton and Loretta H. Mannix, *Mind and Hand: The Birth of MIT* (Cambridge, Mass., 2005), 190–92.

16. Oldenziel, *Making Technology Masculine*, 19–42; Guido Frison, "Some German and Austrian Ideas on *Technologie* and *Technik* between the End of the Eighteenth Century and the Beginning of the Twentieth," *History of Economic Ideas* 6 (1998): 114.

17. *Transactions of the Anthropological Society of Washington* 1 (10 February 1879–17 January 1882): 6–7, 12–14; J. W. Powell, "Human Evolution, Annual Address of the President," *Transactions of the Anthropological Society of Washington* 2 (7 February 1882–15 May 1883): 185; Daniel S. Lamb, "The Story of the Anthropological Society of Washington," *American Anthropologist* 8 (1906): 564–79.

stages of savagery, barbarism, and civilization, but without recourse to the term *technology*. The term is also absent from Mason's influential *The Origins of Inventions*, even though he headed the technology section of the society in the 1880s. Nor did Lester Frank Ward refer to *technology* when addressing the society in 1885 on "Moral and Material Progress Contrasted." Powell did invoke *technology* as "the science of industries" in the title of an 1899 paper, but he dropped the term after the first page. Not until after 1940 did *technology* assume a significant place in English-language anthropology. By then, however, the term no longer referred to the study of material culture, but rather to material culture itself.[18]

Technology had remained a secondary term in the nineteenth century because none of its meanings was particularly novel. It was essentially a Greek neologism for concepts already well developed by the eighteenth century. As used by Beckmann and Bigelow, *technology* hearkened back to the Baconian project for a natural history of the arts—a project largely realized in the *Encyclopédie* of Diderot and d'Alembert. Numerous such works appeared during the nineteenth century with no need for *technology* as an organizing term or keyword.[19] Even late-nineteenth-century educators did not fully embrace the term, preferring *technical education* as the generic, while many institutions continued to designate themselves as "polytechnics," or, when housed within universities, "schools of engineering."[20]

What, then, sparked the shift in meaning that occurred between the nineteenth and twentieth centuries? Part of the explanation lies with what Leo Marx calls the "semantic void" created by the growth of large-scale technological systems; such terms as *industrial arts* were simply inadequate for this process. The meanings of *technology* also changed in response to gender and class struggles over industrialization, as Ruth Oldenziel has argued.[21] These broad factors do not explain the specific shift in meaning, however: the change from *technology* as the study of the practical arts, to

18. J. W. Powell, "From Barbarism to Civilization," *American Anthropologist* 1 (1888): 98, 106–108; Otis T. Mason, *The Origins of Inventions: A Study of Industry among Primitive Peoples* (London, 1895); Lester F. Ward, "Moral and Material Progress Contrasted," *Transactions of the Anthropological Society of Washington* 3 (6 November 1883–19 May 1885): 121–30; J. W. Powell, "Technology, or the Science of Industries," *American Anthropologist* 1 (1899): 319–49. Not until the 1940s did *technology* become a key term in anthropology. Leslie White, "Energy and the Evolution of Culture," *American Anthropologist* 45 (1943): 335–56; V. Gordon Childe, "Archaeological Ages as Technological Stages," *Journal of the Royal Anthropological Institute of Great Britain and Ireland* 74 (1944): 7–24.

19. Notable examples include Edward Knight's *American Mechanical Dictionary* (1876), and E. O. Lami's *Dictionnaire encyclopédique et biographique de l'industrie et des arts industriels* (1881). For a survey of technological encyclopedias, see Eugene S. Ferguson, *Bibliography of the History of Technology* (Cambridge, Mass., 1968), 55–65.

20. For example, Charles G. Washburn, "Technical Education in Relation to Industrial Development," *Science* 24 (1906): 97–112.

21. Marx, "*Technology*" (n. 2 above), 967–68, 977–79; Oldenziel, *Making Technology Masculine* (n. 2 above), chap. 1.

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technology as the artifacts and processes of industrial civilization. The explanation for this shift lies with the German discourse of *Technik*.

Like the United States, Germany was rapidly industrializing during the second half of the nineteenth century. In this context, a new discourse arose around the concept of *Technik*, while the older discourse of *Technologie* declined. As economic historian Guido Frison argues, however, "the notion of *Technik* cannot be considered the heir of *Technologie*." *Technik* and *Technologie* were the focus of independent discourses and almost never compared. Given that these two German terms are today translated into a single word in English, this lack of connection is remarkable.[22]

As did *Technologie*, *Technik* entered German through modern Latin, mainly in the late eighteenth century. Derived from the Greek *tekhne*, *Technik* referred in its broadest sense to the practical rules and methods used to achieve a given end. This usage is similar to current English meanings of *technique*, in the sense that one speaks of the *technique* of a painter or musician. By the mid-nineteenth century, however, *Technik* had also become firmly associated with the industrial arts. Used without modification, *Technik* encompassed all the arts of material production, conceived as a coherent whole. The meanings of *Technik* thus consisted of two related strands: a narrower one referring to the material aspects of industry, and a broader one encompassing the rules, procedures, and skills for achieving a specific goal.[23]

In the second half of the nineteenth century, *Technik* also became central to the self-understanding of the rising German engineering profession. The first pan-German engineering organization, the Verein Deutscher Ingenieure (VDI), embraced *Technik* as the central concept of the new society. The 1856 constitution of the VDI defined its principal goal as advancing German *Technik*, not promoting the interests of engineers. The organization defined membership almost completely in terms of *Technik*, with ordinary membership open to practicing *Techniker*, teachers of *Technik* or technical sciences, and finally owners and managers of technical establishments. Engineers became so identified with *Technik* that most German–English dictionaries give "engineering" as one translation of *Technik*.[24]

This connection between engineers and *Technik* inspired a broad

22. Frison, "Some German and Austrian Ideas on *Technologie* and *Technik*" (n. 16 above), 119. Frison's article is the only work of substance I have found on the shift from *Technologie* to *Technik*.

23. Seibicke (n. 8 above), 212–16, 226–27, 276. This dual meaning was maintained throughout the nineteenth century and into the present. P. K. von Engelmeyer, "Allgemeine Fragen der Technik," *Dinglers Polytechnisches Journal* 312 (1899): 97; *Brockhaus Enzyklopädia* (Wiesbaden, 1973), s.v. "Technik."

24. Kees Gispen, *New Profession, Old Order: Engineers and German Society, 1815–1914* (Cambridge, 1989), 44–48; Gerd Hortleder, *Das Gesellschaftsbild des Ingenieurs* (Frankfurt, 1970), 20; "Statut des Vereins deutscher Ingenieure," *Zeitschrift des Vereins deutscher Ingenieure* 1 (1857): 4; Karl Breul, *Cassell's New German and English Dictionary* (New York, 1936), s.v. "Technik."

debate on the place of *Technik* in modern Germany. With the rapid industrialization that followed German unification, engineers fought for more status within the German social hierarchy, a status they could achieve through *Bildung*—meaning, roughly, education in the principles of high culture. The elite engineers of the VDI, for example, spent considerable time arguing over whether engineers should be required to learn Latin. Most agreed that they should, since classical learning was a necessary component of *Bildung*.[25] Part of this struggle for status involved a philosophical discourse of *Technik* centered around engineers. Philosopher Carl Mitcham calls this discourse the "engineering philosophy of technology" and dates its emergence to the 1877 publication of Ernst Kapp's *Grundlinien einer Philosophie der Technik*.[26]

In the early twentieth century, this discourse blossomed into a full-blown debate over the relationship between *Technik* and *Kultur*. The engineer-philosophers of *Technik* sought to defend the social status of engineering from attacks by humanist intellectuals, the German mandarins. This debate began shortly before World War I, sparked by Eduard von Mayer's *Technik und Kultur* of 1906, which engineers perceived as an attack on their profession. The counterattack was led by the entrepreneur and inventor of X-ray instruments Friedrich Dessauer, who applied a Kantian framework to defend *Technik*, stressing the individual, creative character of invention. As Mikael Hård explains, Dessauer sought to give *Technik* a "spiritual dimension" in order to make it acceptable to the learned elite.[27]

This growing discourse also influenced German social theory. *Technik* emerged as a significant concept among the younger members of the German historical school of economics, including Gustav Schmoller, Max Weber, Georg Simmel, and Werner Sombart.[28] Less concerned than the engineers about the precise nature of *Technik*, these pioneers of German social theory sought, rather, to understand the relationship among *Technik*, *Wirtschaft* (economics), and *Kultur*. *Technik* became particularly important for Sombart after 1900. In the first edition of *Der moderne Kapitalismus* (1902), he discussed at length "die neuen Technik," or modern technology. He then expanded on this theme the following year with an analysis of *Technik* in nineteenth-century Germany in which he stressed the shift from empirical to

25. Gispen, 78–85; Joshua Kundert, "German Engineers and *Bildung* during the Nineteenth Century" (M.A. paper, University of Wisconsin–Madison, 2001).

26. Carl Mitcham, *Thinking through Technology: The Path between Engineering and Philosophy* (Chicago, 1994), 20–27.

27. Mikael Hård, "German Regulation: The Integration of Modern Technology into National Culture," in *The Intellectual Appropriation of Technology* (n. 4 above), 36–43; Mitcham, *Thinking through Technology*, 20–31. For a retrospective account, see Friedrich Dessauer, *Streit um die Technik*, 2nd ed. (Frankfurt, 1958).

28. Frison, "Some German and Austrian Ideas on *Technologie* and *Technik*" (n. 16 above), 107, 119.

scientific methods. Sombart and Weber elaborated their views on *Technik* in 1910 at the first conference of the German Society for Sociology, where Sombart presented a key paper titled "Technik und Kultur." Both Sombart and Weber rejected *Technik* as an independent variable in human history, instead insisting that *Geist* (spirit or mind) had a fundamental, causal role.[29]

Veblen and the Influence of *Technik* on American Social Thought

The breadth and theoretical sophistication of the German discourse of *Technik* are striking when compared to the poverty of American social theory on comparable topics. Given the similar industrial transformation of both countries before World War I, one could expect American social theorists to have taken some note of the German discourse of *Technik*. That discourse did eventually shape American thought, but its influence was diffuse and indirect. Among the several paths *Technik* took to reach American shores, one stands out: the route from the German historical school of economics to the American school of institutional economics.[30] By far the most important agent in this transfer was the iconoclastic American theorist Thorstein Veblen.

Because *Technik* lacked a direct English equivalent, American social scientists faced a quandary when they sought to import the concept from German social theory. Probably the most accurate English rendering of *Technik* during the early twentieth century was "industrial arts," but this translation was rarely made. The closest English cognates, "technique" and "technic," referred primarily to skill in the execution of a fine art such as painting or music. Nonetheless, American scholars sometimes translated *Technik* as *technique*, without recognizing that they were in effect redefining the English word. Had this translation become accepted, it would have transferred into English the Continental distinction between *technique* and *technology*.[31] Instead, *Technik* found a home in American thought by transforming the American meanings of *technology*.

29. Werner Sombart, *Der moderne Kapitalismus* (Leipzig, 1902), 2:42–67, also 1:21n1, 2:1–2; Werner Sombart, *Die deutsche Volkswirtschaft in neunzehnten Jahrhundert* (Berlin, 1903), 153–91, esp. 156; Hård, "German Regulation," 56–60; Werner Sombart, "Technik und Kultur," *Archiv für Sozialwissenschaft und Sozialpolitik* 33 (1911): 305–47; Max Weber, *Wirtschaft und Gesellschaft*, vol. 3 in *Grundriss der Sozioalökonomik* (Tübingen, 1922), 32–33.

30. On the influence of the German historical school of economics, see Jurgen Herbst, *The German Historical School in American Scholarship: A Study in the Transfer of Culture* (Ithaca, N.Y., 1965), esp. 130–31; Joseph Dorfman, "The Role of the German Historical School in American Economic Thought," *American Economic Review* 45 (May 1955): 17–28.

31. *Technik* was sometimes translated as *technology* even in the nineteenth century.

Perhaps the earliest work of American theory inspired by the German discourse of *Technik* was Edwin R. A. Seligman's influential 1901 essay on "The Economic Interpretation of History." The urbane son of a New York banker, Seligman was one of the founders of the Institutionalist school of economics. He made key contributions to public finance and the history of economic thought during his forty-year tenure as a professor of political economy at Columbia University.[32] Seligman had studied in France and Germany, where he became familiar with Marx, Engels, and the debate over historical materialism. In the 1901 essay, Seligman drew on Marx and Engels to argue that economics—which he defined as the social conditions for the sustenance of life—was responsible for "transformations in the structure of society" at least "in the last instance." Seligman was no Marxist, however, and he insisted that Marx's socialism "had no bearing on the truth or falsity of his philosophy of history."[33]

Seligman's economic interpretation of history involved a confounding of *technique* and *technology* that became common among American social scientists influenced by German theories of *Technik*. Seligman's sources abetted his confusion. He quoted both Marx's use of the concept of *Technologie* from *Das Kapital* (rendered as "technology" in the 1887 English translation) as well as a later letter by Engels on *Technik*, translating *Technik* as "technique" when quoting from it. Seligman used Engels to argue that Marx was not claiming that "purely *technical* or *technological* modes of production" were the determinants of history: "Even though it is claimed that changes in *technique* are the causes of social progress, we must be careful not to take too narrow a view of the term [i.e., *technique*]," which encompassed "relations between production and consumption" in general. For this reason, Seligman rejected the "technical interpretation of history" in favor of the "economic interpretation of history."[34] His conflation of *technique* and *technology*, and his abandonment of both for *economic*, illustrate the terminological difficulties in translating the discourse of *Technik* into English.[35]

For perhaps the earliest instance, see the 1887 English translation of Karl Marx, *Das Kapital*, band 1, in Karl Marx and Friedrich Engels, *Werke*, vol. 23 (Berlin, 1968), 530, 632; Marx, *Capital*, vol. 1, trans. Samuel Moore and Edward Aveling (1887; reprint, Moscow, 1954), 475, 567.

32. On Seligman and his economic interpretation of history, see Richard Hofstadter, *The Progressive Historians* (New York, 1968), 197–200; Dorothy Ross, *The Origins of American Social Science* (Cambridge, 1991), 186–89.

33. Edwin R. A. Seligman, "The Economic Interpretation of History, I," *Political Science Quarterly* 16 (1901): 613, 623.

34. Edwin R. A. Seligman, "The Economic Interpretation of History, II," *Political Science Quarterly* 17 (1902): 71, 72, emphasis added. For the original text of Engels's letter quoted by Seligman, see "Engels an W. Borgius," 25 January 1894, in Karl Marx and Friedrich Engels, *Werke* (Berlin, 1968), 39:205–7.

35. The confusion between *technique* and *technology* continued during the 1920s; see, for example, Wesley C. Mitchell, "Sombart's Hochkapitalismus," *Quarterly Journal of*

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Technology, rather than *technique*, carried the industrial connotations of *Technik* into English. The most important agent of this translation was another founder of the Institutionalist school, Thorstein Veblen—without doubt the first American scholar to make *technology* a significant concept in social theory. Drawing on Schmoller and, especially, Sombart, Veblen incorporated the German meanings of *Technik* into the existing meanings of *technology* to create a concept of considerable sophistication.

Both Leo Marx and Ruth Oldenziel have emphasized Veblen's centrality in transforming *technology* into a keyword of modern American culture. Veblen is particularly important in Oldenziel's analysis, which focuses on his later, more polemical works, especially *The Engineers and the Price System*, a collection of articles originally published in 1919.[36] *Technology* and *technological* had become a key part of Veblen's conceptual armory some sixteen years earlier, however, when he used these terms to appropriate the German discourse of *Technik*.

Tracing the sources of Veblen's thought is a difficult task. He read voraciously in a variety of languages and across many fields of social thought, synthesizing his own terminology in the process. Following the scholarly practices of the time, his sources were more often alluded to than cited. His convoluted and often ironic prose can be easily misinterpreted. Scholars disagree on his proximity to various intellectual traditions: although his most fundamental allegiance was to Charles Darwin, others listed among his supposed intellectual predecessors include Herbert Spencer, Edward Bellamy, Henrik Ibsen, Charles Fourier, William James, Jacques Loeb, Franz Boas, Edward Tylor, Karl Marx, Immanuel Kant, Gustav Schmoller, and Werner Sombart. Certainly—and despite significant disagreements with their theories—Veblen drew heavily from Marx and Sombart, writers crucial in shaping his approach and leading him to stress what would now be called the role of *technology* in history. Veblen scholars have not studied his use of technological themes in detail, but they have elucidated the general schema in which these themes played a key part.[37]

Around 1900, Veblen began using *technology* as a concept in his theory of social evolution. *Technology* belonged to a set of socially beneficial tendencies that were opposed by a contrary set of parasitic forces. On the beneficial side stood *workmanship*, *industry*, *the machine process*, and *techno-*

Economics 43 (1929): 303–23; Abbott Payson Usher, "The Genesis of Modern Capitalism," *Quarterly Journal of Economics* 36 (1922): 529.

36. Marx, "*Technology*" (n. 2 above), 976–77; Oldenziel, *Making Technology Masculine* (n. 2 above), 42–46; Thorstein Veblen, *The Engineers and the Price System* (1921; reprint, New York, 1963), chap. 6.

37. Stephen Edgell and Rick Tilman, "The Intellectual Antecedents of Thorstein Veblen: A Reappraisal," *Journal of Economic Issues* 23 (1989): 1003–26; Stephen Edgell, *Veblen in Perspective: His Life and Thought* (Armonk, N.Y., 2001); Rick Tilman, *The Intellectual Legacy of Thorstein Veblen: Unresolved Issues* (Westport, Conn., 1996).

logical knowledge; on the parasitic side lurked *predation*, *business enterprise*, *absentee ownership*, and other *pecuniary* institutions. While Veblen typically expressed this opposition as a conflict between *business* and *industry*, in essence it centered on the distinction between wasteful and productive tendencies in human evolution. He viewed this opposition as universal in human cultures, arising from the conflict between the "instincts" of workmanship and predation. Veblen used this analysis to develop a critique of "modern capitalism" (a term he rarely used, preferring instead "business enterprise" or "the price system"), arguing that the institutions of recent capitalism were incompatible with the peaceful development of modern industry for the benefit of the entire community.[38] *Technology*, in other words, became a key concept in American social theory as part of this critique of capitalism. If an echo of the Marxist opposition between the forces and relations of production can be detected in Veblen, it is no accident. He was simultaneously influenced by Marxist theory and critical of Marx. It does not appear that Marx's occasional use of *technology* shaped Veblen's own use of the term, however; even Veblen's most detailed discussions of Marx mentioned *technology* only in passing.[39]

By 1900, Veblen had already made the opposition between pecuniary and industrial institutions a key element of his theory. He had also made the practical arts, in terms of his "instinct of workmanship," a central agent in his evolutionary anthropology. According to Veblen, increase in the "industrial efficiency of the group" provided the basis for the transition from "peaceable" savagery to "predatory" barbarism. This theoretical framework was already present in 1899 in *Theory of the Leisure Class*, the work that first brought him public acclaim.[40] Veblen did not use the term

38. Edgell, *Veblen in Perspective*, 8–10, 76–99; Thorstein Veblen, *The Instinct of Workmanship, and the State of Industrial Arts* (New York, 1914), 1–4, 145; Tilman, *The Intellectual Legacy of Thorstein Veblen*, 225.

39. Thorstein Veblen, "The Socialist Economics of Karl Marx and His Followers," *Quarterly Journal of Economics* 20 (1906): 575–95. A substantial literature compares Marx and Veblen; see, for example, Edgell, *Veblen in Perspective*, 135; and John P. Diggins, *The Bard of Savagery: Thorstein Veblen and Modern Social Theory* (New York, 1978). On forces versus relations of production, see Karl Marx, "Preface," in *Contribution to a Critique of Political Economy* (reprint, Moscow, 1977).

40. Thorstein Veblen, *Theory of the Leisure Class* (1889; reprint, New York, 1955), 154–55; Thorstein Veblen, "The Instinct of Workmanship and the Irksomeness of Labor," *American Journal of Sociology* 4 (1898): 187–201 (quote on 198). On the industrial–pecuniary distinction, see Thorstein Veblen, "Industrial and Pecuniary Employments," *Publications of the American Economic Association* 2 (1901): 190–235. Veblen did not use the term *technology* before 1900; for examples of his early use of *technological* as a rough synonym for *industrial*, see Thorstein Veblen, "Review of *Einführung in den Socialismus*," *Journal of Political Economy* 5 (1897): 271; Thorstein Veblen, "Why Is Economics Not an Evolutionary Science?" *Quarterly Journal of Economics* 12 (1898): 380, 397; Thorstein Veblen, "The Preconceptions of Economic Science," *Quarterly Journal of Economics* 13 (1899): 249.

invention, the most common keyword of the time for technical change, however; for him, technical change was more about use than innovation.[41]

Technology assumed a significant place in Veblen's writings shortly after 1900, when he turned his attention to the relationship between business enterprise and the "machine process," or modern industry. Like Marx, Veblen sought to explain the fundamental contradictions of modern capitalism by uncovering its historical dynamics. His original term for the technical aspects of these dynamics was *workmanship*, but this carried a strong sense of handicraft and lacked the breadth needed to cover the practical arts from earliest agriculture to large-scale electrical systems. Veblen found this breadth in the German *Technik*, but needed an English word of comparable scope. *Technology*, even in its original meaning as the science of the arts, was as applicable to prehistoric human beings as to MIT graduates. In appropriating *technology*, however, Veblen also transformed it, moving its meaning away from a field of study and closer to material practices and craft knowledge.

Veblen first linked *technology* to *Technik* when he reviewed a work by Gustav Schmoller, a leading figure in the German historical school of economics. According to Frison, Schmoller was among the first German economists to make *Technik* a significant concept in economic theory. In 1901, Veblen published a long, laudatory review of Schmoller's *Grundriß der allgemeinen Volkswirtschaftslehre*. Focusing on methodology, Veblen praised Schmoller for taking a Darwinian approach to economic theory that emphasized the historical genesis of economic forms and the efficient causes that brought these forms into being.[42] Veblen also singled out for discussion the chapter on "Die Entwicklung der Technik in ihrer volkswirtschaftlichen Bedeutung," translated as the "Development of Technological Expedients and Its Economic Significance." This chapter was primarily an overview of the development of the industrial arts from prehistoric times to the "modern West European–American machine age," but included a philosophical discussion of the nature of *Technik*. Veblen praised Schmoller's account of the development of "modern machine industry" but objected to his conservative moralizing on contemporary social questions, particularly regarding "the relation of technological knowledge to the advance of culture," which harked back to the "dreary homiletic waste" of earlier work by the German historical school.[43]

41. On the use–innovation distinction, see David Edgerton, "From Innovation to Use: Ten Eclectic Theses on the History of Technology," *History and Technology* 16 (1999): 1–26.

42. Thorstein Veblen, "Gustav Schmoller's Economics," *Quarterly Journal of Economics* 16 (1901): 69–93, esp. 80–81.

43. Ibid., 89–91; Gustav Schmoller, *Grundriß der allgemeinen Volkswirtschaftslehre* (Leipzig, 1900), 1:187–228, quote on 211; Frison, "Some German and Austrian Ideas on *Technologie* and *Technik*" (n. 16 above), 107, 120. On Schmoller, see Nicholas W. Balab-

Veblen's translation of *Technik* as "technological expedients" is instructive. Schmoller's chapter on *Technik* was from a section titled "Land, Leute und Technik," which Veblen rendered as "Land, Population, and the Industrial Arts," demonstrating that he considered *industrial arts* an appropriate translation of *Technik*. In the same discussion, he also referred to "technological conditions" in a way that implied equivalence to Schmoller's *Technik*. Too adept in both German and English to translate *Technik* as either *technique* or *technology*, Veblen was clearly searching for suitable terminology. Although "technological expedients" provided a fairly accurate rendering of *Technik*, implying as it did a set of means that served industrial ends, not even Veblen himself embraced this phrase.[44]

After his review of Schmoller, *technology* became a new term in Veblen's conceptual armory. It reappeared the following year when he reviewed a book on the arts-and-crafts movement by his friend and colleague at the University of Chicago, Oscar Triggs. Veblen's review was a manifesto for modernist aesthetics, condemning as "sophisticated archaism" the arts-and-crafts movement's rejection of machine production and invoking *technology* to defend his critique. He insisted that art for the worker be "in the spirit of the machine *technology*," associating "art with the machine process and with the *technology* of that process." Although Veblen praised the aesthetic and functional goals of the arts-and-crafts movement, he insisted that its goals could be better reached "through the *technological expedients* of . . . the machine process" than through obsolete craft methods.[45]

Veblen decisively adopted a *Technik*-centered concept of *technology* in 1903, when he reviewed the first two volumes of Sombart's *Der moderne Kapitalismus*. No technological determinist, Sombart made *Technik* a central concept in this work, but insisted that it was not a "driving force" of economic development. As an example, he singled out "the taming of steam," which, despite its significance, "remains only the driving force of a steam engine, without the ability to erect the engine and make it serve specific purposes."[46] Rather than *Technik*, insisted Sombart, the driving forces of economic change were human wants and goals.[47]

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kins, *Not by Theory Alone: The Economics of Gustav von Schmoller and Its Legacy to America* (Berlin, 1988).

44. Veblen, "Gustav Schmoller's Economics," 82, 89.

45. V. [Thorstein Veblen], "Arts and Crafts," *Journal of Political Economy* 11 (1902): 108–11, quotes on 109–11 (emphasis added); Joseph Dorfman, *Thorstein Veblen and His America* (New York, 1939), 204.

46. Sombart, *Der moderne Kapitalismus* (n. 29 above), vol. 2, *Die Theorie der kapitalistischen Entwicklung*, 3–4. *Technik* is largely untreated in volume 1 of the 1902 edition, although the introductory chapter of the 1916 edition contains a brief theoretical discussion.

47. On Sombart, see Hård, "German Regulation" (n. 27 above), 56–60; Torsten Meyer, "Zwischen Ideologie und Wissenschaft: 'Technik und Kultur' im Werk Werner Sombarts," in *Technische Intelligenz und "Kulturfaktor Technik": Kulturvorstellungen von*

Compared to his positive review of Schmoller, Veblen's review of Sombart was mixed. He praised Sombart's "modern, post-Darwinian spirit of scientific inquiry," which sought causal explanations for the historical development of economic institutions. He also endorsed his "careful distinction" between business and industry, a distinction central to Veblen's own work. Nevertheless, he roundly criticized Sombart for his German-centered account of the origins of capitalism. The legal foundations of modern business, insisted Veblen, had their origins on English, not German, soil.[48] This line of criticism was applied a fortiori to Sombart's German-centered analysis of modern industry in his chapter "Die neuen Technik." Contra Sombart, Veblen argued for the English origins of modern industry, fully deploying his new concept of *technology* to support this position. Just as with the legal basis of capitalism, wrote Veblen,

> so also as to the material, the *technological* basis of business enterprise. The industrial revolution, which brought in the *technology* of the machine process and so laid the material foundation of modern business, is, of course, broadly an English fact—whatever fragmentary *technological* elements the English community may once have borrowed from southern Europe.

He insisted that "English-speaking peoples" had retained their lead in the "modern machine industry" until quite recently, when others also came "into the first rank as creative factors in industrial *technology*." "English speech" had no monopoly on "thinking in terms of the machine process," but the epitome of such thinking remained with English speakers, "and this habit of mind is the spiritual ground of modern *technology*."[49]

Historians are unlikely to find clearer evidence of a direct link between the German discourse of *Technik* and a new American discourse of *technology*. Before Veblen, no American social scientist used *technology* as a broad synonym for the practices and principles of industrial arts—the technical basis of modern industry. Still, Veblen, always the careful semanticist, was not simply importing *Technik* into *technology*. Instead, he was constructing

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Technikern und Ingenieuren zwischen Kaiserreich und früher Bundesrepublik Deutschland, ed. Burkhard Dietz, Michael Fessner, and Helmut Maier (Münster, 1996), 67–86; and Thomas P. Hughes, *Human-Built World: How to Think about Technology and Culture* (Chicago, 2004), 61–64. Hård and Meyer provide useful correctives to Jeffrey Herf, *Reactionary Modernism: Technology, Culture, and Politics in Weimar and the Third Reich* (Cambridge, 1984), 130–51. Sombart's trajectory from Marxism to National Socialism limited his postwar influence; see Reiner Grundmann and Nico Stehr, "Why Is Werner Sombart Not Part of the Core of Classical Sociology?" *Journal of Classical Sociology* 1 (2001): 257–87.

48. V. [Thorstein Veblen], "*Der moderne Kapitalismus*," *Journal of Political Economy* 11 (1903): 300–05, quotes on 300 and 303.

49. Ibid., quote on 305 (emphasis added); Sombart, *Der moderne Kapitalismus*, 2:42–67.

a set of related concepts for understanding social and economic change. What would today be termed "modern technology" Veblen referred to as the *machine process*, which he distinguished from *technology*. He clarified his definition of the *machine process* in 1904 in his *The Theory of Business Enterprise*, drawing explicitly on Sombart's chapter "Die neuen Technik" from *Der moderne Kapitalismus*. More than just machines, the *machine process* constituted an entire system:

> The whole concert of industrial operation is to be taken as a machine process, made up of interlocking detail processes, rather than as a multiplicity of mechanical appliances each doing its particular work in severalty.

Veblen's references to "the technology of the machine process" indicated that *technology* was removed from the machine process by a level of abstraction, encompassing not the physical system itself but its principles, the knowledge and skills embodied in its operation. Additionally, he began referring to *technology* as "the state of the industrial arts," a phrase he continued to use throughout his remaining works.[50] This locution also inserted a level of abstraction between *technology* and the *industrial arts*. Veblen's usage was a subtle, semantically consistent combination of the older definition of *technology* as a field of knowledge with the German concept of *Technik* as a set of material practices. This subtlety would be lost on later users of the term.

Over the next few years, Veblen developed his idea of *technology* into a sophisticated concept that combined the idea of *technology* as *Technik* with the original meaning of *technology* as a field of knowledge. A complete examination of Veblen's theory would require a separate article, but two points are crucial for understanding later developments. First, Veblen developed the first explicit analysis of the relationship between *science* and *technology*, but one so recondite that subsequent scholars failed to grasp its significance. (Such discussions were common in German analyses of *Technik*.)[51] Second, he conceptualized *technology* as the collective knowledge of the industrial arts—knowledge shared by the entire community—which allowed him to incorporate *technology* into his critique of capitalism.

Veblen analyzed the relationship between *science* and *technology* in his 1906 article, "The Place of Science in Modern Civilization," in which he traced scientific and technological knowledge to two distinct instincts: *workmanship* and *idle curiosity.* He argued that these instincts developed autonomously: idle curiosity became the basis of modern science, while workmanship drove the shift from handicrafts to the machine process.

50. Thorstein Veblen, *The Theory of Business Enterprise* (New York, 1904), 7, 302.

51. For example, Sombart, *Der moderne Kapitalismus* (n. 29 above), 2:42–67; Sombart, *Die deutsche Volkswirtschaft in neunzehnten Jahrhundert* (n. 29 above), 156–57.

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Despite the fundamental autonomy of these two processes, the machine process did shape modern science, in particular through a shift from craft to machine models of causation in nineteenth-century science. The utility of science thus resulted from a "fortuitous . . . coincidence" that made possible "the employment of scientific knowledge for useful ends in technology, in the broad sense in which the term includes, beside the machine industry proper, such branches of practice as engineering, agriculture, medicine, sanitation, and economic reforms."[52] Veblen's analysis of the *science–technology* relationship was possible only because of his *Technik*-centered definition of *technology*. There were no discussions of this relationship in the nineteenth century, when *technology* was clearly understood as a field of science and the relationship was simply that of part to whole.[53]

Veblen soon elaborated his idea of *technology* in a 1908 article, "On the Nature of Capital," which connected a generalized concept of "technological knowledge" to his critique of capitalism. He began by arguing that technological knowledge, which included language, the use of fire, the use of simple tools for cutting, and basic fiber arts, was integral to all human communities, even the most primitive. Such knowledge constituted what Veblen termed the "immaterial equipment" of production, as opposed to the material equipment of tools and machines. Technological knowledge was both collective, exceeding the grasp of any single individual, and cumulative, growing through experience transmitted by members of the group. Natural resources, machinery, and other types of physical capital became useful only through collective technological knowledge.[54] When this material capital was in short supply, however, individuals could in effect monopolize the community's collective technological knowledge by controlling the material means needed to utilize this knowledge, such as labor or land, and thus create "the basis of pecuniary dominion." For Veblen, ownership of what Marx called the means of production represented in effect a theft of the community's collective technological knowledge.[55]

By the first decade of the twentieth century, Veblen had taken *technology* far from its nineteenth-century meaning as the "science of the industrial arts." His concept was surprisingly sophisticated, in many ways compatible with the nondeterministic understanding of the term that has been developed by historians of technology since the 1960s. The extent of his in-

52. Thorstein Veblen, "The Place of Science in Modern Civilization," *American Journal of Sociology* 11 (1906): 585–609, quote on 597–98.

53. Sombart, for example, described "die moderne Technik" as "a twin-sister of modern natural science." Sombart, *Der moderne Kapitalismus*, vol. 3, pt. 1, 78. A description of *technology* as the twin sister of modern *science* would not have made sense in nineteenth-century English.

54. Thorstein Veblen, "On the Nature of Capital [Part 1]," *Quarterly Journal of Economics* 22 (1908): 517–42, quotes on 518 and 521.

55. Ibid., 525–26, 534.

novations is not immediately apparent, however, from his definition of *technology* as the "state of the industrial arts." For Veblen, *technology* included knowledge as well as practices, while remaining firmly independent of science. As used by Veblen, the term encompassed productive pursuits in all human epochs, not just the era of modern industry, while also covering a broad sweep of human activities, from domestication of animals to large-scale industrial systems. He emphasized *technology* in use, refusing to reduce it to invention. Insofar as Veblen had a theory of technological change, he emphasized gradual accretions of skill and knowledge rather than major breakthroughs. His understanding of *technology* was, in principle, neither deterministic nor progressive. "Technological proficiency" was itself neutral, neither "intrinsically serviceable [nor] disserviceable to mankind." Veblen saw nothing that was automatically beneficial in the progress of technological knowledge, particularly when used for military purposes or socially pernicious commerce. In addition, his understanding of *technology* emphasized human agency, not the determining effects of material forces. He argued that the historical role of capital goods, and by implication *technology*, "is a question of how the human agent deals with the means of life, not of how the forces of the environment deal with man."[56]

There was, nonetheless, a latent determinism and progressivism in Veblen's theory. He assumed that the autonomous development of "technological proficiency" was beneficial unless contaminated by predatory instincts. Growth in the human mastery of the material world served as the principal progressive motor of history. This progressivist, deterministic undercurrent in his concept of *technology* strengthened over time and is especially evident in his last book, *Absentee Ownership*.[57]

Veblen's ideas about *technology* reached full flower in his most controversial work, *The Engineers and the Price System*, a book based on a collection of articles written for the leftist periodical *The Dial* in 1919. In these articles, Veblen detailed conditions for a revolutionary overthrow of the "vested interests," always with the caveat that any such overthrow was a "remote contingency." As the leaders of this revolutionary overthrow, Veblen anointed "production engineers," whose rule would be effected by a "Soviet of technicians." Most of the controversy of the book can be traced directly to this surprising role for engineers.[58]

Veblen scholars differ substantially in their interpretation of *The Engineers and the Price System*. According to Rick Tilman's summary of this

56. Ibid., quote on 542; Thorstein Veblen, "On the Nature of Capital [Part 2]," *Quarterly Journal of Economics* 23 (1908): 104–36, quote on 110.

57. Thorstein Veblen, *Absentee Ownership and Business Enterprise in Recent Times: The Case of America* (Boston, 1923), 62–63.

58. Elizabeth W. Jorgensen and Henry I. Jorgensen, *Thorstein Veblen: Victorian Firebrand* (Armonk, N.Y., 1999), 157–58, 160; Edgell, *Veblen in Perspective* (n. 37 above), 27; Veblen, *The Engineers and the Price System* (n. 36 above), esp. 127–29.

debate, some scholars view the book as a "serious program of reconstruction for the American economy," while others see it as Swiftian satire intended to expose the failures and inequities of modern capitalism.[59] In terms of Veblen's concept of *technology*, however, *The Engineers and the Price System* was thoroughly grounded in his prior works.

Veblen's emphasis on engineers was a logical extension of his earlier analysis, particularly as developed in "On the Nature of Capital" and *The Theory of Business Enterprise*. These works portrayed *technology* as a form of knowledge belonging to the entire community, a point repeated in *The Engineers and the Price System*. Traditionally, argued Veblen, skilled craft workers were the vanguard of *technology*. The "new technological order," however, required not only highly skilled workmen, but also "a corps of highly trained and specially gifted experts" who, like the skilled workers, based their expertise on the collectively held stock of technological knowledge. These "experts" did not constitute a clearly defined occupation; for want of a better term, Veblen suggested that they "be called 'production engineers.'" He most certainly did not advocate giving control of industry to the existing engineering profession, which he viewed as thoroughly subservient to the "vested interests," a subservience that made the engineer the "awestruck lieutenant of the captain of finance." Veblen's "Soviet of technicians" was not to consist of these "commercial" engineers, but rather of non-pecuniary industrial experts who would be faithful stewards of technological knowledge—the collective property of the entire community. In effect, Veblen's "Soviet of technicians" constituted a utopian vision of the liberating potential of technology, a vantage point for critiquing the existing technological order.[60]

The Engineers and the Price System was Veblen's most controversial and widely read book. Oldenziel has argued that it portrayed "engineers as the chief bearers of technical knowledge" and helped spread a concept of *technology* centered on engineers. I am convinced that this was not Veblen's intent. Nevertheless, scholars as astute as Daniel Bell have reached essentially the same conclusion. Many contemporary readers surely missed the irony in Veblen's analysis, particularly his distinction between the existing engineering profession and the non-pecuniary industrial experts who would form his "Soviet of technicians," just as many may have found an engineer-centered concept of *technology* in the work. Regardless of Veblen's intent, *The Engineers and the Price System* undoubtedly helped to popularize the idea of *technology* as "the state of the industrial arts," a definition

59. Tilman, *The Intellectual Legacy of Thorstein Veblen* (n. 37 above), 175–76.

60. Veblen, *The Engineers and the Price System*, 72, 82, 85; Janet Knoedler and Anne Mayhew, "Thorstein Veblen and the Engineers: A Reinterpretation," *History of Political Economy* 31 (1999): 262–64; Edgell, *Veblen in Perspective*, 140–42, 151–58; Tilman, *The Intellectual Legacy of Thorstein Veblen*, 187–89. As Knoedler and Mayhew demonstrate, Veblen's interpretation drew on tendencies among rank-and-file engineers.

much closer to the German concept of *Technik* than to the nineteenth-century American understanding of the term.[61]

From Veblen to Beard: Determinism Ascendant

After World War I, *technology* diffused slowly among American social scientists, who were influenced in part by Veblen but also by the continuing unconscious appropriation of the German discourse of *Technik*. As it spread, however, the term lost most of the subtle distinctions that Veblen had employed in making it part of his critique of capitalism. The few scholars who embraced the term during the 1920s shed his abstraction of *technology* from the industrial arts, instead defining it as equivalent to the industrial arts, or *Technik*. At the same time, social scientists jettisoned his antideterminism and wrapped *technology* in the mantle of progress.

The influence of Veblen's concept of *technology* is difficult to gauge. While in some respects Veblen was one of the most important social scientists of the early twentieth century, he remained outside the main currents of American social science. His stress on evolutionary and qualitative themes was at odds with the increasing influence of social-scientific models, especially in economics, that were drawn from the physical sciences. Further, his iconoclastic stance and episodic academic career deprived him of all but a few graduate students.[62] Still, one can find many direct connections between Veblen and later scholars who used *technology* in their work.[63]

One of the earliest economists to employ the term in its new meanings was Veblen's student, colleague, and later patron, Herbert Davenport. In late 1904, Davenport published an analysis of the concept of capital. Echoing Veblen's distinction between the pecuniary and industrial, he distinguished "technological" or "social" capital from "competitive" capital. For Davenport, competitive capital was defined by market valuation, whereas techno-

61. Oldenziel, *Making Technology Masculine* (n. 2 above), 44–46; Daniel Bell, "Introduction to the Harbinger Edition [New York, 1963]," in Veblen, *The Engineers and the Price System*, 1–35.

62. Dorfman, *Thorstein Veblen and His America* (n. 45 above), 504–9; Oldenziel, *Making Technology Masculine*, 43; Ross (n. 32 above), 321, 372.

63. See Wesley C. Mitchell, "Human Behavior and Economics: A Survey of Recent Literature," *Quarterly Journal of Economics* 29 (1914): 25–29; Ralph C. Epstein, "Industrial Inventions: Heroic or Systematic," *Quarterly Journal of Economics* 40 (1926): 261–62; Abram L. Harris, "Economic Evolution: Dialectical and Darwinian," *Journal of Political Economy* 42 (1934): 35; C. E. Ayres, "Moral Confusion in Economics," *International Journal of Ethics* 45 (1935): 189–90. Mitchell was a close friend of Veblen and a leading contributor to the Institutionalist school of American economics; Ayres drew heavily on Veblen to keep Institutionalism alive after 1930. James R. Stanfield and Jacqueline B. Stanfield, "The Significance of Clarence Ayres and the Texas School," in *Is Economics an Evolutionary Science? The Legacy of Thorstein Veblen*, ed. Francisco Louçã and Mark Perlman (Cheltenham, U.K., 2000), 83–94.

logical capital referred to "all wealth held for the purpose of production," including intermediate products. Davenport was not entirely comfortable with this use of "technological," however. In a footnote, he remarked that "etymologically speaking, there are manifest objections to this use of the term 'technological' as referring especially to capital regarded in the mechanical and industrial sense; but no better term seems to be at hand."[64] This remark provides clear evidence of the tension between the old and new meanings of *technology*.

Davenport was at least discomfited by the terminological confusion surrounding *technology*. Subsequent scholars tended to treat the concept as unproblematic, not recognizing that they were using the term in a new way. One early example of this confusion is found in a 1921 article by a young economist, Alvin Hansen, who took issue with Seligman's 1901 article on "The Economic Interpretation of History." Hansen attacked Seligman's characterization of Marx's theory of history as "economic" and instead insisted that the theory was "technological." In contrast to Seligman's deep familiarity with European Marxism, Hansen's research was shallow and monolingual, and his analysis conveyed a narrow, deterministic view of Marx and Engels. He insisted on defining Marx's "forces of production" as *technology*, while identifying "relations of production" as *economics*. Hansen's dichotomy was a form of boundary work that excluded *technology* from the proper scope of economics. More interesting, however, was his nearly interchangeable use of *technology* and *technique*, along with *technological* and *technical*, a clear echo of Seligman's usage and an example of the unrecognized merger of *Technik* into *technology*. In addition, Hansen's exclusion of *technology* from *economics* helped separate the concept from critiques of capitalism. Hansen's narrow view of *technology* marked a decline in conceptual sophistication from Veblen's usage.[65]

Another change did even more to shift *technology* from critique to apologetics—its connection to a deterministic concept of material progress. At the vanguard of this conceptual change was the Progressive historian Charles Beard. After joining the faculty at Columbia University in 1904, Beard embraced the economic interpretation of history developed by his colleague Seligman. Beard left Columbia in 1917 to protest wartime

64. H. J. Davenport, "Capital as a Competitive Concept," *Journal of Political Economy* 13 (1904): 31–47, quote on 35. On Davenport, see Wesley C. Mitchell, "Thorstein Veblen," in *What Veblen Taught: Selected Writings of Thorstein Veblen* (New York, 1936), xxix; and Dorfman, *Thorstein Veblen and His America*, 254–56.

65. Alvin H. Hansen, "The Technological Interpretation of History," *Quarterly Journal of Economics* 36 (1921): 72–83. For a convincing refutation of Hansen's analysis of Marx, see Donald MacKenzie, "Marx and the Machine," *Technology and Culture* 25 (1984): 473–502. On Hansen, see W. Robert Brazelton, "Alvin Harvey Hansen: A Note on His Analysis of Keynes, Hayek, and Commons," *Journal of Economic Issues* 27 (1993): 940–48; and W. Robert Brazelton, "Alvin Harvey Hansen: Economic Growth and a More Perfect Society," *American Journal of Economics and Sociology* 48 (1989): 427–40.

infringements on academic freedom, and in 1919, he helped found the New School for Social Research. He was soon joined by Thorstein Veblen, whom Beard greatly admired.[66] Like many Progressives, Beard's enthusiasm for reform was coupled with a profound faith in the progress of civilization. Stripped of its Marxist dialectic, the economic view of history promised that material progress would lay the basis for moral progress. In the late 1920s, Beard added *technology* to economics as a motive force in history, a shift that occurred at a time when his faith in economics as the principal motor of history was beginning to fade.[67]

Beard first granted this new role to *technology* in his 1926 presidential address to the American Political Science Association. In discussing the changes in American society since 1783, he singled out the transformations wrought by the steam engine and spinning machinery, changes that, he claimed, suggested important lessons for the future. Two key ideas "thrust themselves upon us" when looking forward in history: the "pitiless reality of the time-sense," and "the ideas of indefinite progress—the continuous conquest of material environment by applied science." He formulated this second idea—the march of material progress—explicitly in terms of *technology*.[68]

As Leo Marx, John Kasson, David Nye, and others have documented in great detail, Beard's parade of the wonders of material progress was standard rhetoric in American culture. From the early years of the American republic, orators, editorialists, and intellectuals embraced the technological marvels of their day as visible manifestations of progress. As an American historian, Beard knew this rhetoric intimately. Beard's novelty lay in explicitly linking the term *technology* to the idea of progress in a way that made *technology* itself the motive force of history. He did so in paradigmatic language that reverberates into the present:

> Not one whit less inflexible [than time] is technology—also a modern and Western Leviathan. Like time, it devours the old. Ever fed by the irrepressible curiosity of the scientist and inventor, stimulated by the unfailing acquisitive passion—that passion which will outlive capitalism as we know it and all other systems now imagined by dreamers—technology marches in seven-league boots from one ruthless, revolutionary conquest to another, tearing down old factories and industries, flinging up new processes with terrifying rapidity, and offering for the first time in history the possibility of realizing the idea of progress so brilliantly sketched by Abbé de Saint-Pierre.

66. Hofstadter (n. 32 above), 179, 197–200, 285–88; Dorfman, *Thorstein Veblen and His America*, 394, 449–51.

67. Hofstadter, 200; David W. Marcell, *Progress and Pragmatism: James, Dewey, Beard, and the American Idea of Progress* (Westport, Conn., 1974), 274–76.

68. Charles A. Beard, "Time, Technology, and the Creative Spirit in Political Science," *American Political Science Review* 21 (1927): 4–5.

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Under the "convulsive pressures of technology," he continued, all systems of thought would be transformed.[69]

Beard's use of *technology* was obviously influenced by Veblen, particularly the more deterministic language of *Absentee Ownership*. In effect, he made manifest the latent determinism in Veblen's theory. While his *technology* lacked Veblen's subtlety, his version of the concept proved more enduring for a number of reasons.[70] First was his notion of autonomous technological change, metaphorically likened to the inalterable movement of time, driven by "curiosity" and "acquisitive passion" grounded in human nature itself—a formulation that recalls Veblen's theory of instincts, while effacing his distinction between productive and pecuniary pursuits. Second, *technology*, not economics, became the key determinant in history, ruthlessly transforming not just material culture but also intellectual and spiritual life. Third, this autonomous, deterministic force was not to be lamented but rather embraced as an agent of beneficent progress. Finally, Beard divorced *technology* from capitalism, insisting that its influence was independent of any specific economic system. With its firm faith in human progress, Beard's concept of *technology* was better suited to defending the established order than critiquing it, and with the possible exception of his last point, his prose could inspire present-day technological enthusiasts.

Beard was a few years ahead of his time in his passionate use of *technology*. The term did not become a significant category in the social sciences until the late 1930s.[71] Like most of his contemporaries, he did nothing to theorize *technology* and failed to recognize that he was adopting a novel concept. Even in his subsequent works, Beard used *technology* inconsistently, favoring instead such phrases as "machine civilization" and "science and the machine." Beard used this last phrase interchangeably with *technology*, describing "science and the machine" as the unstoppable driving force of history.[72] With Beard, one sees not only the merging of *technology* with

69. Ibid., 5; Leo Marx, *The Machine in the Garden: Technology and the Pastoral Ideal in America* (New York, 1964); John F. Kasson, *Civilizing the Machine: Technology and Republican Values in America, 1776–1900* (New York, 1976); David Nye, *American Technological Sublime* (Cambridge, Mass., 1994). Thanks to Leo Marx for helping me clarify Beard's relationship to this earlier tradition.

70. Charles W. Beard, "Introduction," in J. B. Bury, *The Idea of Progress: An Inquiry into Its Origin and Growth* (New York, 1932), xx; Charles A. Beard and William Beard, *The American Leviathan: The Republic in the Machine Age* (New York, 1930), vii.

71. When scholars in the 1920s dealt with subjects we would now classify as *technological*, they used the term only in passing. William F. Ogburn, *Social Change with Respect to Culture and Original Nature* (New York, 1922), 200–13; S. C. Gilfillan, "Who Invented It?" *Scientific Monthly*, December 1927, 529–34; Abbott Payson Usher, *A History of Mechanical Inventions* (New York, 1929), vii, 1, 6; Stuart Chase, *Men and Machines* (New York, 1929); S. C. Gilfillan, *Sociology of Invention: An Essay in the Social Causes of Technic Invention and Some of Its Social Results* (Chicago, 1935).

72. See Beard's introductions to two collections of essays: Charles A. Beard, ed.,

progress, but also the blurring of the distinction between science and *technology* that would bedevil scholarly use of the term in the future.

Conclusion

I have argued that the German discourse of *Technik* helped to transform the American concept of *technology*, shifting its meaning from a field of study to the object of study—that is, from the study of the industrial arts to the industrial arts themselves. This process is most clear in the work of Thorstein Veblen, who drew on his German sources to develop *technology* into a sophisticated concept central to his critique of capitalism. Scholars who adopted Veblen's concept, most notably Charles Beard, usually abandoned this critical aspect. Beard himself embraced a deterministic, progress-centered idea of *technology* that jettisoned Veblen's skepticism about the benefits of technological change. Within American social theory during the 1920s, a struggle arose over the emerging definitions of *technology* between those who viewed it as subject to the contingencies of human history and those who treated it as a determining force outside human history.

The influence of the European concept of *Technik* on the American concept of *technology* persisted well beyond the 1920s, as is apparent in the continued confusion of the terms *technique* and *technology* in the writings of American scholars steeped in European social theory.[73] This confusion continued even after World War II, particularly in the English-language works of such European critics as Herbert Marcuse and Jacques Ellul.[74]

The history presented here is just one part of the larger analysis required to understand the extraordinary power of the present-day concept of *technology*. The early-twentieth-century semantic shift in *technology* did not simply make the English word equivalent to *Technik*. Instead, *technology*'s nineteenth-century meanings persisted, transforming by 1930 from the "science of the arts" to "applied science." The result was an awkward combination of *Technik* and *applied science*, but because *technology* was simultaneously familiar and recondite, the agents of these transformed

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Whither Mankind: A Panorama of Modern Civilization (New York, 1928), 1–25, esp. 14; and Charles A. Beard, ed., *Toward Civilization* (New York, 1930), 1–20.

73. See, for example, Talcott Parsons, "Sociological Elements in Economic Thought," *Quarterly Journal of Economics* 49 (1935): 437, 448–49; Robert K. Merton, *Science, Technology and Society in Seventeenth-Century England* (1938; reprint, New York, 1970), 155, 184, 190–91; Lewis Mumford, *Technics and Civilization* (1934; reprint, New York, 1963), 7, 11–12, 109–10. On Mumford, see Arthur P. Molella, "Mumford in Historiographical Context," in *Lewis Mumford: Public Intellectual*, ed. Thomas P. Hughes and Agatha C. Hughes (New York, 1990), 41.

74. Herbert Marcuse, *One-Dimensional Man: Studies in the Ideology of Advanced Industrial Society* (Boston, 1964); Jacques Ellul, "The Technological Order," *Technology and Culture* 4 (1962): 394–421.

meanings did not recognize the new hybrid they had created. This hidden polysemy has contributed to a pernicious conflation of meanings that tends to reduce the whole of the industrial arts to invention, and invention to applied science. This conflation has profound ideological implications, helping sustain a mystifying, deterministic discourse that portrays technological change as the inevitable fruit of scientific discovery.[75]

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75. The conflation of the *Technik*-centered and *applied-science* meanings of *technology* is particularly clear in William F. Ogburn, "Technology and Sociology," *Social Forces* 17 (1938): 1.