Maastricht University

Introduction

Citation for published version (APA):

Bijker, W. E., Hughes, T. P., & Pinch, T. J. (1987). Introduction. In *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology* (pp. 9-15). MIT Press.

Document status and date:
Published: 01/01/1987

Document Version:
Publisher's PDF, also known as Version of record

Please check the document version of this publication:

• A submitted manuscript is the version of the article upon submission and before peer-review. There can be important differences between the submitted version and the official published version of record. People interested in the research are advised to contact the author for the final version of the publication, or visit the DOI to the publisher's website.
• The final author version and the galley proof are versions of the publication after peer review.
• The final published version features the final layout of the paper including the volume, issue and page numbers.

Link to publication

General rights
Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

• Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
• You may not further distribute the material or use it for any profit-making activity or commercial gain
• You may freely distribute the URL identifying the publication in the public portal.

If the publication is distributed under the terms of Article 25fa of the Dutch Copyright Act, indicated by the “Taverne” license above, please follow below link for the End User Agreement:

www.umlib.nl/taverne-license

Take down policy
If you believe that this document breaches copyright please contact us at:

repository@maastrichtuniversity.nl

providing details and we will investigate your claim.

Download date: 01 Oct. 2023

I

Common Themes in Sociological and Historical Studies of Technology

Introduction

System builders are no respecters of knowledge categories or professional boundaries. In his notebooks Thomas Edison so thoroughly mixed matters commonly labeled economic, technical, and scientific that his thoughts composed a seamless web. Charles Stone and Edwin Webster, founders of Stone & Webster, the consulting engineering firm, took as the company logotype the triskelion, to symbolize the thoroughly integrated functions of financing, engineering, and construction performed by their company, an organization responsible for many mammoth twentieth-century engineering projects. Nikolai Lenin, a technological enthusiast, also had a holistic vision when he wrote, "Soviet power + Prussian railroad organization + American technology + the trusts = Socialism" (quoted in Gillen 1977, p. 214). Perhaps Walther Rathenau, the head of Allgemeine Elektrizitäts-Gesellschaft, Germany's largest manufacturing, electrical utility, and banking combination before World War I, epitomized the drive for integration and synthesis, both in his person and in the organizations he created and directed. He envisaged the entire German economy as functioning like a single machine, and he observed that in 1909 "three hundred men, all acquainted with each other [of whom he was one], control the economic destiny of the Continent" (Kessler 1969, p. 121). In *Man Without Qualities* (1930), the novelist Robert Musil characterized his Rathenau-like protagonist, Arnheim, as the embodiment of the "mystery of the whole."

Many engineers, inventors, managers, and intellectuals in the twentieth century, especially in the early decades, created syntheses, or seamless webs. The great technological systems, utility networks, trusts, cartels, and holding companies are evidence of their integrating and controlling aspirations. Essays and books calling for the displacement of the mechanical with the organic also testify to these yearnings. The desire for systems and networks may have resulted in part from the rise of electrical and chemical engineering and the spread of a mode of thinking and organization associated with them. Electrical and chemical relationships, in contrast to mechanical or linear ones, are conceived of in terms of circuits, networks, and systems. Gear trains, cams, and followers are the linear interconnections common to the mechanical.

"Technology/science," "pure/applied," "internal/external," and "technical/social" are some of the dichotomies that were foreign to the integrating inventors, engineers, and managers of the system- and network-building era. To have asked problem-solving inventors if they were doing science or technology probably would have brought an uncomprehending stare. Even scientists who thought of themselves as pure would not have set up barriers between the internal and the external, if these would have prevented the search for solutions wherever the problem-solving thread might have led. Entrepreneurs and system builders creating regional production complexes incorporated such seemingly foreign actors as legislators and financiers in networks, if they could functionally contribute to the system-building goal. Instead of taking multidivisional organizational layouts as airtight categories, integrating managers such as Stone and Webster saw a seamless web.

Historians and sociologists who want to study technology in this way should choose as their subject matter such inventors, engineers, managers, and scientists or the organizations over which they presided or of which they were an integral part. The dichotomies would promptly evaporate. Historians and sociologists choosing such subjects would do research and writing in which the technical, scientific, economic, political, social, and other categories would overlap and become soft. Some historians of science and technology still take the categories and dichotomies seriously because they write about nonproblem-solving, category-filling academics.

In this first part of our book we present three different approaches to deal with this seamless web of technology and society. Also, these chapters explicate the need and possibility of synthesizing ideas and methods from the disciplines of sociology and history for studying technology. Together the chapters demarcate a research program for studying the development of technological artifacts and systems—a research program that aims at contributing to a greater understanding of the social processes involved in technological development while respecting the seamless web character of technology and society.

The first chapter of part I begins with a brief critical review of the technology studies literature. Trevor Pinch and Wiebe Bijker outline their social constructivist approach using the case study of the bicycle. Thomas Hughes, in the second chapter, describes his approach to "technological systems" by specifying such terms as "technological style," "reverse salient," and "momentum." Hughes's argument is richly illustrated with a variety of examples. In the third chapter Michel Callon uses his study of electric vehicle development in France to sketch the actor-network approach. He casts engineers as practicing sociologists and concludes that sociology in general would benefit from a sociology of technology that seeks to apply the engineers' own methods.

Of the themes addressed in this part of the volume, the seamless web concept is most pronounced. In this respect, all authors address the science/technology dichotomy. Pinch and Bijker argue that both science and technology are socially constructed cultures and that the boundary between them is a matter for social negotiation and represents no underlying distinction.

Thomas Hughes stresses that the science and technology labels are imprecise and do not convey the messy complexity of the entities named. He also defines science in part as knowledge about technology and technology as embodied knowledge, so that the distinctions again tend to fade. In addition, Hughes sees some scientists as developing technology, a function usually associated with engineers, and some engineers as doing research in ways usually associated with scientists. Hughes also believes that enthusiastic problem solvers and dedicated system builders are no respecters of disciplinary and knowledge boundaries. From his essay the reader may conclude that Hughes, as historian, would prefer to avoid the middle-level abstractions, such as science and technology, and write of particular actors doing particular things. His frequent use of case histories gives evidence of this.

Michel Callon proposes in his essay that the question of who is a scientist and who is a technologist is negotiable according to circumstances. He, like Hughes, believes that "the fabric has no seams." Callon asks why one should categorize the elements in a system or network "when these elements are permanently interacting, being associated, and being tested by the actors who innovate." Faced by the abstract categories problem—science, technology, economics, politics, etc.—Callon takes a different tack from Hughes, who prefers specific cases or examples in lieu of middle-level categories. Callon uses a higher abstraction, "actors," that subsumes science, technology, and other categories. Actors are the heterogeneous entities that constitute a network.

Callon's actors include electrons, catalysts, accumulators, users, researchers, manufacturers, and ministerial departments defining and enforcing regulations affecting technology. These and many other actors interact through networks to create a coherent actor world. Callon does not, therefore, distinguish the animate from the inanimate, individuals from organizations. The actor world shapes and supports the technical object, an electric vehicle in the case Callon presents. Electricité de France (EDF) in fulfilling its program for developing an electric vehicle (VEL) virtually writes a script or provides a scenario in which the actors' roles are so defined and their relationships so bounded that the VEL is conceived by and becomes a coextension of the actor world. In concepts reminiscent of Martin Heidegger, the VEL is the physical artifact that the actors are destined to bring forth, enframe, and sustain (Heidegger 1977, p. 19). Callon believes that there is no outside/inside (that is, social/technology) dichotomy.

Pinch and Bijker, in contrast, preserve the social environment. The web is not seamless in this regard, and Pinch and Bijker develop other conceptual themes. The social environment, for instance, shapes the technical characteristics of the artifact. With their emphasis on social shaping, Pinch and Bijker deny technological determinism. Borrowing and adapting from the sociology of knowledge, they argue that the social groups that constitute the social environment play a critical role in defining and solving the problems that arise during the development of an artifact. Their emphasis on problem solving during the development of technology is like Hughes's on reverse salients and critical problems. Pinch and Bijker point out that social groups give meaning to technology and that problems—Hughes's reverse salient—are defined within the context of the meaning assigned by a social group or a combination of social groups. Because social groups define the problems of technological development, there is flexibility in the way things are designed, not one best way. This approach is like that in "the Empirical Programme of Relativism," a sociology of knowledge program stressing that scientific findings are open to more than one interpretation.

Pinch and Bijker, drawing again on the "Empirical Programme," also introduce the concept of closure. Closure occurs in science when a consensus emerges that the "truth" has been winnowed from the various interpretations; it occurs in technology when a consensus emerges that a problem arising during the development of technology has been solved. When the social groups involved in designing and using technology decide that a problem is solved, they stabilize the technology. The result is closure. Closure and stabilization, however, are not isolated events; they occur repeatedly during technological development. To use Hughes's language, a reverse salient has been corrected, but countless others will emerge as the technology is invented, developed, expanded, and improved. Returning again to the role of social groups stressed by Pinch and Bijker, various groups will decide differently not only about the definition of the problem but also about the achievement of closure and stabilization.

From the early history of the bicycle, Pinch and Bijker provide examples of closure and stabilization, social shaping, interpretative flexibility, and the influence of social groups. In this case history they present technological development as a nondetermined, multidirectional flux that involves constant negotiation and renegotiation among and between groups shaping the technology. Their model is far from the rigid, categorized, linear one sometimes presented for technological development. They, like Callon and Hughes, find it difficult to use conventional categorizing language to describe continuous change. They need a language analogous to calculus.

Pinch, Bijker, Hughes, and Callon are searching for a language and for concepts to express their new understanding of technological change. In addition to the seamless web, systems, actors, networks, closure, stabilization, and social construction, they explore conservative and radical change, balances and imbalances in evolving technological systems, translation, heterogeneity, and research sites. With regard to conservative and radical change, Pinch, Bijker, and Hughes note that inclusion in a group, organization, or bureaucracy dampens the originality of inventors and innovators (Bijker, this volume). High inclusion brings mission orientation or commitment to incremental improvements in the evolving technological system with which the group, organization, or bureaucracy has identified. The outsiders, Hughes believes, create the radical inventions that must stand initially without substantial organizational support. Radical inventions are often stifled by organizations that consider them a threat to the technology that they nurture. But radical inventions are often the geneses of new systems.

Dynamic imbalance and reverse salients in systems are comparable concepts found in the Callon and the Hughes essays. The use of the concept follows from conceiving of technology as a growing system or network. Because actors or components in a system are functionally related, changes in one or more cause imbalances or reverse salients in the advancing system front until the other components cascade and adjust to achieve an optimal interaction. Because the technological systems are growing or changing, the analysis should be analogous to dynamics (the study of motion and equilibrium) rather than to statics (the study of rest and equilibrium). System components interacting harmoniously—without imbalances or reverse salients—while the system grows can be thought of as being in dynamic equilibrium.

Callon argues that a new actor world and the technology it sustains are not, as has often been said of invention, a new combination of old entities or components. One cannot simply shop in an imaginary technology-component supermarket and then assemble a combination. The actors, whether consumers, fuel cells, or automobile manufacturers (as in the case of Callon's electric vehicle example), must have their attributes defined for them, or translated,[1] so that they can play their assigned roles in the scenario conceived of by the actor-world designer. To use Hughes's language—and Edison's approach—each component in the system has to be designed to interact harmoniously with the characteristics of the others. Callon and Hughes speak as one when they insist that organizations as well as physical artifacts have to be invented for systems and actor worlds. If existing organizations of artifacts are to be used, then they must be translated. Callon, however, stresses how difficult this is once the translation has been made to fix or stabilize it. The heterogeneous actors in the network tend to revert to their former roles or to take on others, and so the network, or system, breaks down. These failures should, Pinch and Bijker believe, be of as much interest to historians and sociologists of technology as the success stories. In saying this they are borrowing from the "Strong Programme" in the sociology of scientific knowledge that calls for sociologists to be impartial to the truth or falsity of beliefs so that they can be explained symmetrically (Bloor 1973).

Pinch and Bijker also borrow from the sociology of knowledge as they recommend that scholars interested in the development of technology choose controversy as one important site for research. The controversy in question is over the truth or falsity of belief or about the success or failure of a technology in solving problems. They show that different groups will define not only the problem differently but also success or failure. They reinforce the wisdom that there is not just one possible way, or one best way, of designing an artifact.

Pinch and Bijker also urge historians and sociologists of technology to borrow from the sociologists of knowledge, who deal with the content of science. They urge historians and sociologists to open the so-called black box in which the workings of technology are housed. Citing M. J. Mulkay, they acknowledge that it is easier to show that the social meaning of television depends on the social context in which it is used than to demonstrate that a working television set is also context dependent. They also realize that demonstrating how the technical characteristics, or meaning, of artifacts, such as electrical generators and transformers, are socially constructed is difficult, but they note that some historians of technology have done case studies of this kind. Callon and Hughes also want the black box pried open. In his essay Hughes provides some instances of the social shaping within the black box.

Note

1. In his contribution to this volume, Callon does not explicitly use the concept "translation," but the idea is implicit in much of his argument. See Callon (1980b, 1981b, 1986) and Latour (1983, 1984).