Metascience (2024) 33:127–130
https://doi.org/10.1007/s11016-023-00919-9

BOOK REVIEW

Not a static structure, not science alone, but revolutions

Venkatesh Narayanamurti & Jeffrey Y. Tsao: The genesis of techno scientific revolutions: rethinking the nature and nurture of research. Cambridge, MA: Harvard University Press, 2021, 248 pp, € 32.95 HB

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Accepted: 30 September 2023 / Published online: 29 October 2023

The Genesis of Techno Scientific Revolutions is a book about how science and research has developed from the perspective of two experts who have been working at Bell Labs their entire careers. Coming from a perspective of practical expertise, it could be claimed that the authors are, at the core, "counter idealists" about how science and engineering function. Rather than making assumptions about how science, or engineering, or any other research activity is supposed to work, they focus on how it has worked in practice. As a result, the book can be considered a contribution to "philosophy of science in practice" (PSP), but the authors go even further in depicting the structures in which research and development take place than prescribed by the ideals of PSP. Although the authors are writing about "how science is" rather than how "it should be" ideally, they do answer the question of how science should be from their own holistic experience, including their reflection from their own experience, which is remarkably valuable. There is an opponent that the authors have in mind. It is a view still held by many, even those conducting scientific research. It is that science "determines" the limitations of technology, and the pace of technological development is thus limited by scientific development.

The authors argue that there is always something fundamental about any kind of technological application and so there is necessarily a relationship toward fundamental research. In this sense, they contextualize research (not only science) not as restrictive as logical positivists, but not in the sense that any theory is free to be used without restraint. Unlike the unstructured liberty that is usually associated with postmodern understandings of science, they build many well-structured models in which transfers of distinct kinds of reasonings, practices, and structures are possible within different parts of technoscience.

The title of the book is insightful. As Ian Hacking writes in *Representing and Intervening*, book titles mean a lot as they reflect how an author positions their

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book to a large audience, based on what the audience has as background knowledge (Hacking 1983). This book is not about "structure" as in Thomas Kuhn's *The Structure of Scientific Revolutions* (see Kuhn 1962), but about "genesis," and the revolutions being studied are "technoscientific" rather than "scientific." The revolutions are also sets of wider, larger human activities, which are illustrated with great case studies. The story here is an "origin story" of evolutionary thinking, which references the famous evolutionary theorist and paleontologist Stephen J. Gould.

The book is a fascinating work—even a manual perhaps—for conducting research through seeing research activity as a part of complex cultural activity. The book takes a perspective that sees science and engineering in a continuum and not as distinct aspects of human intellectual and practical enquiries. The social aspect within research is quite explicitly pointed out: "The first formal research organization, Thomas Edison's Menlo Park Laboratory, formed in 1876, was a social enterprise. The great industrial research laboratories of the twentieth century, including Bell Labs, IBM, Xerox PARC, Dupont and GE—were social enterprises. Today's research universities, research institutes and national and international laboratories are social enterprises" (205).

The general inspiration of the three chapters of the book are the following three issues: (1) philosophy of science, particularly Thomas Kuhn's philosophy of science; (2) the scaffolding and punctuated equilibrium evolutionary understanding of Stephen J. Gould; and (3) the authors' own experience in research and development as experts in these fields. I believe that the experience that the authors bring is the strength of the book, which is contained not just in the third chapter, but in the other parts as well, since the book is not exactly a philosophy of science, and neither is it an orthodox science and technology studies book. It is an insiders' story from the Bell Labs.

The book is a rigorous intellectual effort to make the reader aware of some of the most prominent and interesting frameworks of thinking about the development of science and technology that occurred during the 1990s and 2000s. The book should be seen as a manual to help people think about, design, and develop research activities through new conceptual frameworks, frameworks that give primacy neither to science nor to technology. Throughout the book, the authors have kept the conceptual distinction between science and technology, and they expand this dichotomy to many different models that they produced about knowing, developing technology, learning, and research activity. For example, S (Science) and T (technology) develop into the form of S' and T' or Questions and Answers which, through different processes of nestedness and punctuated equilibrium, are transformed into Q' and A', and sometimes as steps to develop a certain technology. However, the authors use these frameworks not only as abstract categories of activities, but in order to construct an incredibly detailed mapping of the interrelationships between these similar dichotomies, nurturing, and developing each other. These relationships are dialectical and lead to progress and development of novel technology, frameworks, understandings, and other research-related scaffolded entities. In that sense, the authors' understanding subsumes science and technology under the general category of human curiosity. However, the concepts of science and technology are still categorized separately without being blended into each other, and the microdynamics of both science and technology are expanded to model the scientific development, discovery, and research leading to inventions such as the transistor and the laser (49, 56). The separate but interconnected categories of science and technology are reminders of dialectical processes within epistemology.

Employing the dichotomous structure, and sometimes the difference, between science and technology, the authors describe how they recursively built different models of many different dynamics within research and development to understand breakthroughs of different kinds of technologies and different aspects of human reasoning. The book walks the reader through three dichotomies (i) research—application, (ii) science—engineering, and (iii) fundamental—applied to demonstrate the interrelation of these activities within research. The authors call these dichotomies "stylized facts" (7). The continuum within these dichotomies is their first stylized fact, the modularity within questioning and answer-finding is their second stylized fact, and their third stylized fact is that the evolution of knowledge occurs via punctuated equilibria. The strength of the book is that the authors' ontology in research is quite rich and includes many different aspects of research activities. The authors never offer a simple dichotomy between science and technology. They see both fields in a web interwoven of many different dichotomies that are expressed within technoscience. And the greatest strength of the book is that it is a book length argument about how "everything is related" within technoscience, not in the sense that everything is connected in the pragmatic sense, but in the sense that, given enough time, what is fundamental can transform itself into what is practical through the invention of a new field, and what is fundamental can shift into the practical, as was the case with quantum mechanics (176).

In three chapters, this dichotomous structure is recursively presented: in Chapter One, as technology and science; in Chapter Two, as questions and answers; and in Chapter Three, as normal science and the breakthrough. The fourth chapter is different from the first three. It is about governing technoscience and is in the form of a handbook of a successful research laboratory, following the principles that were laid out in the previous three chapters. It also contains novel understandings of the more human aspects of research such as team leadership.

One conceptual critique I have about this generalized human culture and endeavor is that the book does not develop a contextualized understanding of technoscience within a culture. The book assumes some form of universality of cultures of technoscience. This becomes clear epistemically when one asks: How do the authors model the culture itself outside and inside of technoscience? They do it by using the vagueness of the concept to employ the richness of the category of culture to develop their models of interrelation of science and technology. What cultures, in plural, are related to the given technoscience culture that they have talked about in the USA remains an open question. In fact, they employ very fine-grained and enlightening concepts throughout the book when they discuss science, technology, and their role within culture. However, the concept of culture itself is not detailed apart from applications of the concept within the contexts of certain research cultures. As a result, the coarseness of the concept of culture stands out. In the end, the reader is presented with descriptively accurate and detailed understandings within technoscience, but to what extent these structures can be generalized is left unanswered.

Funding Open Access funding enabled and organized by Projekt DEAL.

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