Technological Change

The Evolution of Technology. GEORGE BASALLA. Cambridge University Press, New York, 1989. viii, 248 pp., illus. Cambridge History of Science.

For the better part of a century, two broadly divergent perspectives have oriented scholarship on the nature of modern technological change. The "revolutionary" view provided the initial point of departure, first attaining academic stature in Arnold Toynbee's lectures on the Industrial Revolution (1884). Then in the 1920s an "evolutionary" perspective began to emerge as an intellectual counterforce. Over the years, the general contours of the controversy have remained largely unchanged, although sustained criticism of the revolutionist viewpoint has recently tilted the balance of power perceptibly toward the evolutionary position. Now, in a major contribution to the discourse, George Basalla has done scholars a valuable service, for his forthright defense of the evolutionist position may, ironically, convince them to discard the evolution-revolution dichotomy and begin afresh.

Chief among the book's virtues is the clear and direct—indeed, elegant—manner in which Basalla's argument unfolds. He takes as his starting point the vast "diversity" of objects in the man-made world. How to explain such diversity? Biological necessity will not do, he argues cogently, not even to explain the adoption of such a fundamental invention as the wheel. Instead, he proposes "a theory of technological evolution" that emphasizes the social, political, and economic context of technological change. The bulk of the study explores the "evolutionary analogy" in depth, ranging widely over centuries and cultures and drawing examples from the history of technology, economic history, and anthropology.

Three principal concepts underlie Basalla's theory: continuity, novelty, and selection. Obviously, continuity among artifacts must obtain, he notes, for the evolutionary analogy to hold. And through a series of case studies, he does indeed demonstrate that all artifacts—real or imagined—have had antecedents in the natural or made world. Wrongheaded ideas of discontinuous or revolutionary change, he maintains, have derived their strength, on the one hand, from Western ideas and institutions (especially nationalism and the patent system) and, on the other, from a tendency to confuse technological changes with their "truly revolutionary" economic and social consequences. When one focuses on the proper unit of analysis, the artifact, one finds "technological continuity," even in those momentous changes that ushered in the Industrial Revolution in Britain.

Yet, in order for change to occur, "novelty," in Basalla's words, "must find a way to assert itself in the midst of the continuous." And, as he amply demonstrates, technological novelty has had manifold sources, above all in Western societies. Most are familiar ones: economic pressures, institutionalization of research, and changes in technological knowledge induced by diffusion or by advances in scientific understanding. Others, such as "fantasy and play," have received scant attention. In all, Basalla's masterly survey covers such an array of sources that it seems bound to escape the confines of a tidy theory, which, as he notes, "would have to encompass the irrationality of the playful and fantastic, the rationality of the scientific, the materialism of the economic, and the diversity of the social and cultural."

Having established that novelty does indeed find points of entry, Basalla comes at last to the issue on which the viability of his theory rests: the dynamics of selection. What is it in the material world, where human beings intervene, that serves as an analogue to survival value in the physical world? As Basalla himself acknowledges, "survival value becomes an amorphous concept when applied to technology." So again he eschews a general theoretical account, instead mining the evolutionary analogy for insight into the "diverse and conflicting forces"—economic, military, social, and cultural—that have shaped historical processes of selection.

It is here, on a middle-level theoretical ground, that Basalla is at his best, whether the subject be novelty or selection. Sensible yet insightful observations follow one upon the other—about the relationship between science and technology, about patent systems, about alternative paths, and (in a concluding chapter) about the cultural boundedness of notions of technological progress.

In short, Basalla uses the evolutionary analogy to good effect, but how well has he defended a "theory" of technological evolution? His treatment of novelty and selection lacks the rigor that marks his treatment of continuity, yielding little more than a catalogue of relevant factors. The study might have been more convincing had he made better use of the recent literature, provided a fuller bibliography (not to mention regular footnotes), and treated some important issues (and authors) in a less cursory fashion. Yet a deeper problem would have remained. By equating evolution with continuity, Basalla has in effect made a straw man of the revolutionary perspective: since no artifacts have emerged without any antecedents whatsoever, it follows that none qualifies as revolutionary. To my knowledge, however, no one has ever defined the term "revolution" in such a way as to require complete discontinuity. And to make matters worse, Basalla himself acknowledges that some artifacts—"seminal inventions," he calls them—have been more important than others. With that admission, he seems unavoidably to have resurrected something like the revolutionary view, and this is when one begins to suspect that the evolution-revolution discourse ought to be set aside once and for all. Fortunately, Basalla's own insights at an intermediate level of analysis may well provide the building blocks for a more rigorous and sophisticated theory of technological change.

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Coevolution: Cautious Views

Chemical Mediation of Coevolution. KEVIN C. SPENCER, Ed. Academic Press, San Diego, CA, 1988. xvi, 609 pp., illus. $95.

For the past 25 years, herbivorous insects and their host plants have been the preeminent systems claimed to exemplify coevolution. The term itself was popularized by Ehrlich and Raven in a classic paper, "Butterflies and plants: a study in coevolution" (*Evolution* **18**, 586–608 [1964]), in which taxonomic patterns of host use by butterflies were used to develop the thesis that plant evolution—particularly the evolution of defensive chemical compounds—has been stimulated by insect herbivores, which in turn adaptively radiated in response to the pharmacopoeia. In *Chemical Mediation of Coevolution*, some (only some) of the leading students of plant-insect interactions, joined by one student of herbivorous mammals and one of chemical mimicry, describe