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The Nature of Technology – What It Is and How It Evolves

W. Brian Arthur, Allen Lane, 2009, 246 pages, £22.00

Brian Arthur's pioneering work on increasing returns and Complexity Theory is well known. In this ambitious and fascinating book, he attempts a complete *sui generis* reworking of how we understand the dynamic world of technologies and the economies that use them.

For Arthur, a technology is organised around a principle of how to exploit natural or social phenomena for some particular purpose. Each one is made up of component sub-technologies and can in turn act as a building block for other technologies. From these abstract premises, Arthur develops a 'combinatorial' theory of technological evolution. Since all novel technologies are combinations of existing technologies, the potential for new technologies grows exponentially with the number extant. At the same time, the need for new technologies grows rapidly, not least to support other emerging technologies and offset the problems they create. In this sense, technology is self-creating. Arthur repeatedly applies biological metaphors to the machine world of technology. It 'builds itself organically from itself', with cascades of novelty only partially offset by mass extinction events (as obsolete technologies are superseded). The representative individual modern technology is 'a fluid thing, dynamic, alive, highly configurable'; and the jet engine, for example, is a 'metabolism', a set of interacting parts that senses and reacts to its environment. These organic metaphors help shake us out of our mechanistic way of looking at technology, to reveal aspects that are usually ignored.

There are many particular insights. Technology's relationship with science is symbiotic, with technology as important to the evolution of science as science is to the development of technologies. Likewise, technological innovation is not something that happens to an economy and to which it must adjust; rather both economy and technology develop in a continual process of mutual reconfiguration. For Arthur, the economy is 'an expression of its technologies': it mediates the creation of new technologies, and these in turn continually alter the structure of the economy. This echoes and develops Schumpeter's insights about the process of creative destruction incessantly changing the economy 'from within'. Arthur also combines an understanding of increasing returns with subtle epistemological arguments to account for technology 'lock-in' and the clustering of new technology providers.

Arthur perhaps goes too far in his efforts to demystify the process of innovation at the micro-level. He insists that an invention stands on a 'pyramid of causality' and 'tends to show up when the pieces necessary for it, and the need for it, fall into place'. His language of finding solutions rather than creating them implies that, by the time an invention is made, the solution is already 'out there' waiting to be noticed. But the number of possible permutations of existing conceivably pertinent technologies is often so vast that an inventor must create, as much as find, a feasible path to a new solution. I would also argue that the required imaginative receptiveness to new connections and perspectives, and imaginative ability to build a vision of how things might be, is more unusual than Arthur implies. Imagination is a key ingredient of novelty.

Arthur writes in a clear and accessible style, but the book is not always an easy read. It operates at a level of abstraction and with a frequency of precise redefinition of terms some will find off-putting. The abstraction is, though, relieved by numerous beautifully explained examples of real technologies. The text is also peppered with practical pointers for how to manage technology businesses.

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