The Business History of New Technologies

This special issue draws together a number of articles linked to the theme of the business history of new technologies. All of them were submitted to the Business History Review in the normal course of operations, but they are grouped together here because of their common concerns and interlinkages. The articles cover numerous wide-ranging issues, but it may be particularly worthwhile to point out the light they shed on a number of related discussions about the role of internal and external sources of innovation in the firm, the creation of organizational capabilities, and the proprietary control of innovation in some of the dominant new product technologies of the twentieth century: microcomputers, videocassette recorders, telephones . . . and chickens—that is, chickens in their capacity as the material for genetic engineering.

Alfred D. Chandler, Jr., and William Lazonick, writing business history in the broad tradition of Joseph Schumpeter, have stressed that organizational forms and capabilities make a key contribution to economic growth and that the most important of these are the economies of scale, scope, and learning that have been developed within large firms. These views are often counterposed to a tradition of Marshallian economics that has highlighted the role of “external economies” operating through competition and the interaction of firms in markets and networks. “Organizational capabilities” are important in both views, but there is often vigorous debate about where they are best created.

In an article analyzing the development of the microcomputer industry since the 1970s, Richard Langlois argues that these models should not be rigidly counterposed. He concludes that in the microcomputer industry, capabilities have developed primarily in a decentralized external market rather than in vertically integrated firms, “a case quite exactly opposite to the picture of progress that Chandler paints in Scale and Scope.” Neither IBM, nor Apple, nor Microsoft has become a dominant, oligopolistic “first mover.” But Langlois also stresses that it is often the dynamic interaction of internal and external capabilities that has proved most productive.

Thus, the powerful mainframe computer companies like IBM and Hewlett-Packard did not use their powerful internal organizational capabilities to pioneer in microcomputers. Instead, they
stood to one side in the 1970s as a diverse collection, first of hobbyists and software pirates, and then of start-up companies like Apple, Osborne, and Kaypro, shaped the industry and its technology around a pattern of design networks, open systems, and outsourcing. When IBM addressed itself seriously to entering this market in the early 1980s, it had to bypass its own organizational structures, break its own rules, and in effect sponsor its own start-up company to compete against itself, in order to find the innovative flexibility to break into the market.

Having entered the market in this way, IBM initially embraced open standards for its PC, declining to fight an uphill battle to defend patent and proprietary rights against fast-moving cloners. Instead, it actively accepted the growth of outsourcing and independent external innovation on the basis of IBM-compatibility. Subsequent attempts by IBM (with the PS/2), DEC, and Compaq to “close” standards through the introduction of proprietary or incompatible machines resulted in corporate near-disasters, as clone-makers launched their own alternative standards and forced the larger companies to re-externalize to remain competitive. Proprietary standards, notably those of IBM and Apple, have tended to converge, and open standards and modularity have come to be regarded as almost inevitable.

In part, Langlois argues, this pattern is linked to the characteristics of product and technology in the industry. Unlike mass consumer products in sectors like automobiles and consumer electronics, the product grew before the extent of its uses was defined, creating a high degree of uncertainty and change. Consequently, whereas traditional mass producers had often found that they could innovate faster at the center than their suppliers, the reverse was true in microcomputers. Moreover, the distinctive role of modularity in computer design also enhanced the scope for external innovation, since one part of a system could change without all other parts having to change with it.

The origins of the videocassette recorder industry, discussed in the article by Michael Cusumano, Yiorgos Mylonadis, and Richard Rosenbloom, cast interesting light on Langlois’s line of argument in a different context. In contrast to the persistence of open standards and external networks in microcomputers, the VCR industry passed through a decisive struggle over standards at an early stage of its development. Large firms fought a battle to determine a dominant product design and then competed on the
basis of developing superior capabilities in mass production and incremental product improvements.

Sony, with its Betamax system, was the first mover in the industry, but it was surpassed by the joint operations of JVC and Matsushita, which entered as second movers with an alternative and improved product (VHS) and captured a position of dominance in the industry. In part, this was a battle between two organizations or groups with highly developed internal organizational capabilities. Sony established an early lead through its design and production skills but was unable to sustain it in the face of comparable technical skills allied to the greater mass production capabilities of its rivals. But Cusumano, Mylonadis, and Rosenbloom stress that, in an industry in which demand was so enormous and growing so exponentially, the key element of Matsushita’s success was not superior internal capabilities, but rather its ability to outpace Sony in global commercialization by creating a global network of allied mass producers and distributors in Japan and the United States linked together behind their preferred standard.

Thus, as in the computer industry, the interaction of internal and external capabilities proved decisive. Like the computer industry, for instance, standards were decisively shaped by the external development of complementary products (software and prerecorded tapes), which created bandwagon effects and network externalities, and the capacity of leading firms to relate to or ally themselves with these forces was vital. But the differences were perhaps even more important. First, unlike the computer industry, the mass production of video equipment was a demanding and complex product-engineering and manufacturing business—not a component assembly operation—and reliance on decentralized suppliers was more hazardous. Second, and most important, the nature of the product was fundamentally different. The microcomputer is really a system in a box; the VCR is ultimately an appliance. In this sense, the videocassette recorder industry did not have a “battle of the systems,” but rather a duel between differentiated but essentially similar technologies. In this context, Sony’s key mistake, the authors argue, was to interpret a small technical advantage as a decisive lead in product definition and to leave itself vulnerable to a strategic coalition of producers that moved more decisively into mass production and distribution.

Yet, if the microcomputer’s character as a system was crucial to the enhanced role of external networks in that industry, it may
seem paradoxical that the telephone industry, which until the computer age epitomized modern “systems” industries, was perhaps the most centralized and internalized of any of the new industries of the early twentieth century.

Louis Galambos shows how Theodore Vail, AT&T's chief executive between 1907 and 1919, combined an aggressive pursuit of monopoly with corporate dedication to technical innovation in the telephone industry. This combination of strategies, he notes, seems to contradict some of the basic contentions of theories of antitrust and bureaucracy, which predict that monopolies will be sluggish innovators.

Thus AT&T’s pursuit of a “universal system” based on standardization and interconnectedness could have been conducive to a corporate culture of adaptive changes and “perfection through standardization.” But Vail’s achievement was to link these aspects of the organization to an equally strong commitment to the quest for fundamental or formative innovations that could change the nature of the entire system—notably the amplifier and repeater systems that opened up transcontinental long-distance service, or innovations in transistors and switching systems.

At an earlier stage, Vail and others had believed that such innovations had necessarily to come “from the outside,” notably from pure scientists at MIT or Harvard. Yet Vail was able to construct a powerful corporate culture and to recruit a cadre of leading managers who were able to build a powerful innovative center within the company (at the Bell Labs), to run in parallel with the more adaptive culture embodied by Western Electric. Galambos concludes that the experience of AT&T indicates the need for a “theory of the innovative firm” to try to define the conditions under which internal organizational capabilities (including culture and ideology as well as strategy) can substitute for the pressures of the market in pushing technical innovation forward.

Vail certainly developed a high level of internal innovation within a hierarchical and vertically integrated corporation. The contrast with the microcomputer industry may well have much to do with contrasts between the products themselves. Unlike the microcomputer, telephony was not modular, the end use of its product was more clearly defined, and the technical capabilities in the core firm were far ahead of those of its suppliers. On the other hand, in the light of recent technical innovations in telephony, it is at least possible to imagine that telephony might have followed
a different technological trajectory had AT&T not acted so early and so decisively to “close” the technological paradigm of the industry. In that case, Vail’s greater achievement might have been his adroit trade-off of an acceptance of government regulation and supervision in return for the continuation of AT&T’s quasi-monopolistic position.

Firms in technology-based industries need to generate innovation for continuing competitive success; but for maximum profitability, they also need to control and appropriate the fruits of their innovations. AT&T’s “closed” system resolved this problem in telephony. In microcomputers, clones and software piracy have made this more problematic (though Microsoft may be an example of at least short-term success in this field). In biotechnology, a quintessentially research-driven industry, this question is at the heart of the industry. Glenn Bugos shows how, in chicken breeding, the control of genetic variation through hybridization provided a route to control of intellectual property protection that was more powerful than the patent system and laid the basis for an industrial structure in which breeding remained distinct and independent from the otherwise vertically integrated chain of chicken farming.

The central innovation was the development of hybridization since the 1950s. This not only created advantages of genetic uniformity and “hybrid vigor,” but also created a “genetic lock” on the intellectual property of the industry, since chicken farmers could not reproduce the hybrid pattern through breeding, which now required complex control of trait selections and breeding sequences. The breeding industry became highly specialized, R&D-led, and hard to enter. It required relentless research and testing to respond to the needs of producers and to constantly shifting dangers from disease or unanticipated consequences of genetic changes. By the 1980s, 90 percent of U.S. broilers came from the stock of half a dozen breeders.

This tight, specialized, and research-led sector, however, also provided the basis of standardized genetic raw material, out of which a vertically integrated mass production chicken-farming industry developed. A highly vertically integrated system of hatching, supplying, housing, processing, branding, and distribution grew up, dominated by firms like Tyson’s, Holly Farms, and Perdue, building on the opportunities for standardization and mass production provided by the genetic controls of the breeders and
symbolized by the speedy and scientific slaughter of the chicken dis-assembly lines. In this industry at least, a key element of technology and innovation was provided externally and remained separate from the giant firms that developed the organizational capabilities of large-scale production and distribution in the industry.

This collection of articles raises intriguing issues about the large corporation and external and internal sources of innovation. In one case (chicken farming), large firms have depended on innovations developed externally; in another (microcomputers), these external innovations have substituted for the development of large firms; in another (telephony), large firms have internalized the innovation process almost by force majeure; and in yet another (VCRs), the internal organizational capabilities of single firms had to be welded into a sort of global network in order to dominate the industry. These combinations do not exhaust the possibilities, but they do provide a valuable basis to carry forward the discussion of technical innovation and organizational capabilities.

—S.T.