COMPETITION-THROUGH-INNOVATION: THE THIRD INDUSTRIAL STAGE

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ABSTRACT

This presentation describes a three-stage historical model developed as a part of a Ph.D. dissertation analyzing competition between U.S. and Japanese companies in electronics-related industries. The model is similar to that described by Piore and Sabel in *The Second Industrial Divide*, but companies under the third stage do not succeed by reacting quickly to exogenous technological change but by repeatedly leapfrogging their competitors through product and process innovation. This shifts the focus from the mechanical *production process* to the collaborative *innovation process*, which requires social systems to support collective learning.

Introduction

There has been much written about the economic changes brought on by global competition and the emergence of new technologies including solid-state electronics, micro-computers, biotechnology and the Internet. Various contributors attempting to understand the nature of this change have introduced terms such as "flexible specialization," "the new competition," "the knowledge worker," and more recently "the new economy".[1] While many observers have analyzed and attempted to characterize the nature of these changes, few have attempted to provide fully developed models.

The exception is the model provided by Piore and Sabel.[2] While this model was useful when it was introduced in the early 1980s, the character of the economy has changed considerably since then. As a result, there is a need for a newer, more up-to-date model to serve as a guide to the new economy. Furthermore, there have been some weaknesses uncovered in the Piore and Sabel model that need to be addressed. In particular, this model: 1) does not provide an adequate explanation of the link between technology and change; 2) fails to adequately distinguish between the behavior of companies in traditional industries versus those in newly emerging technologies; and 3) characterizes all companies as *reacting* to exogenous technological change rather than recognizing that some generate it endogenously through continuous innovation.

Within this context I would like to outline a three-stage historical model that emerged from a Ph. D. dissertation at the New School.[3] This dissertation analyzed the changing nature of competition between U.S. and Japanese companies in electronics-related industries. The resulting model differs from the Piore and Sabel model in four primary respects: 1) the driving force resulting in each industrial transformation is the emergence of a superior competitive strategy not previously feasible due to limitations

in the scope of markets and the nature of technology; 2) various industrial segments are affected differently because the emerging strategy cannot be fully applied in all segments; 3) the dominant mode of competition in emerging sectors today is described as Competition-Through-Innovation rather than flexible specialization; and 4) the dominant structure in emerging sectors today is described as flexible *integration* rather than flexible specialization.

Two Industrial Transformations

Although the model has three industrial stages, the focus of this discussion will be primarily on the two industrial transformations that take place when one stage is replaced by another. The first transformation to be focused upon took place in the mid-nineteenth century when an economy made up of small firms utilizing craft technology gave way to one dominated by large corporations. The second transformation began taking place in this country in the early 1970s and is still taking place today. In this case an economy in which large corporations sought to capture and hold markets by utilizing economies of scale to undercut competitors prices is giving way to an economy in which companies or networks of companies use product and process innovation to repeatedly leapfrog their competitors, gaining temporary monopolies until one of their competitors does the same.

The Driving Force for Change

In this model, the driving force that brings about each industrial transformation is the competitive superiority of a new competitive strategy made feasible by changes in economic and technological circumstances. The competitive strategy that emerged out of the first transformation in the mid-nineteenth century was *competition-through-economies-of-scale* while the strategy that is emerging now is *competition-through-innovation.* In each case, the change in competitive strategy results in changes in both how economic value is produced and how firms and social institutions are structured. Whereas *competition-through-economies-of-scale* required large corporations, mechanistic production systems, bureaucratic control and governmental regulation, *competition-through-innovation* requires networks, collaborative innovation systems, cooperation among peers and facilitative support by institutions.

Competition-through-economies-of-scale is a strategy in which companies utilize economies of scale to reduce the unit cost of standardized products or services and compete based on price. Since increased market share means that fixed costs can be distributed across a larger volume, companies adopting this strategy can achieve a virtuous circle in which increased market share leads to decreased cost which, in turn, leads to a further increase in market share, a further reduction in cost, etc. Once a company achieves market dominance, that company can undercut the prices of competitors seeking to penetrate the market. When companies, beginning with the railroads in the

mid-Nineteenth century, began adopting this competitive strategy, economic behavior and structure began to change dramatically.[4] Whereas firms under craft production had little incentive to grow beyond a limited, optimum size, once competition-through-economies-of-scale emerged, competition changed dramatically with entrepreneurs such as Vanderbilt,

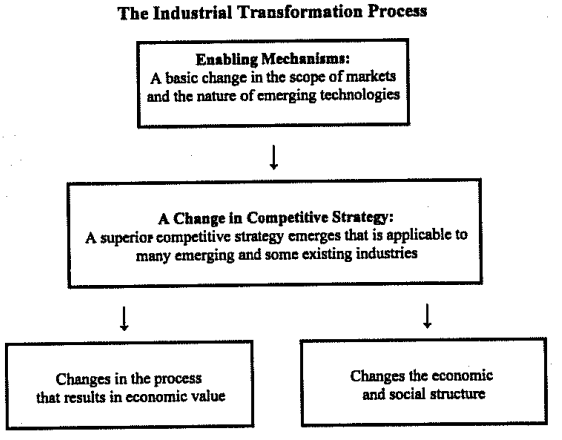

Figure 1

Rockefeller and Carnegie racing their competitors to capture markets and take advantage of economies of scale.[5] This change in strategy sometimes led to cutthroat price competition and other times to monopolies.[6] It also led to macroeconomic instability, Keynesian regulation and government regulation in general.[7]

Competition-through-innovation is the strategy that in recent years has come to dominate high technology industries such as electronics and computers. Under this strategy, companies no longer seek to capture and hold markets for long periods of time based on efficient production, but instead seek to repeatedly introduce new or essentially new products, thereby achieving a series of temporary monopoly positions. Companies such as Intel, for instance, do not compete by producing the same CPU chip for a long period of time at the cheapest price, but instead compete by repeatedly racing their competitors to introduce the most advanced (and most profitable) CPU chip. This strategy has become dominant in industries where products are knowledge- rather than resource-intensive, because international competition has made it difficult to profit from the manufacture of such products once they become commodities.

Just as the previous shift to competition-through-economies-of-scale led to dramatic changes in economic behavior and structure, so has adoption of competition-through-innovation. Whereas corporations under competition-through-economies-of-scale sought to integrate vertically so as to capture and hold markets, competitors under competition-through-innovation have become increasingly dependent on collaborative networks. Critical to the success of Silicon Valley computer firms relative to the microcomputer firms on Route 128 in Boston, for instance, was the fact that Silicon Valley firms, utilizing open systems and specializing in individual components, could main-

tain a more rapid pace of innovation than could Boston firms which utilized proprietary systems and therefore had to advance the technology of whole systems.

Enabling Mechanisms

Although each new competitive strategy represents an advance relative to the one that went before, it can emerge only after certain changes take place in the scope of markets and technology making it feasible.

A. Competition-Through-Economies-of-Scale:

1) Changes in market scope: In the mid-1800s, national markets resulted from the development of railroad and telegraph networks extending across the nation and the weakening of local and state barriers to trade. Competition-through-economies-of-scale emerged first in industries such as the railroads, oil refining, chemicals and meat-packing, where technological limitations on manufacturing did not have to be overcome.

2) Changes in technology: Prior to 1850, a forty-year effort by the federal government to develop the technology for producing guns with interchangeable parts had resulted in the development of precision machining capabilities. This meant that once railroads made markets national in scope, entrepreneurs in newly emerging industries producing such products as sewing machines, harvesting machines and bicycles could hire machinists from the gun industry with the capabilities needed to advance manufacturing methods toward mass production. These efforts, in turn, provided the foundation for mass production to be fully realized with Henry Ford's assembly line.

B. Competition-Through-Innovation:

1) Changes in market scope: In the late 1900s, trade became international in scope as international travel and communication became commonplace, national barriers to trade were weakened and foreign competition was introduced into national markets. In the 1970s, a first step toward competition-through-innovation was taken when Japanese companies began using continuous improvement as a competitive strategy in the automobile, consumer electronics and semiconductor industries.

2) Changes in Technology: Prior to 1970, a twenty year effort by the federal government to obtain miniaturized components for defense and aerospace needs resulted in the both the development of solid state electronics technology and collaborative networks of companies and institutions engaged in collaborative innovation. Solid state electronics resulted in the development of a whole range of products that were knowledge- rather than resource-intensive. Since the cost of manufacture of these products was generally small compared to the cost of research, development and design, and since international competition made it difficult to profit from manufacture of products that had become commodities, companies sought to maintain differentiation by introducing new products at ever-faster rates.[8] This trend was extended in the 1980s, when the computer industry shifted from proprietary to open systems, allowing innovation to take place within networks such as the one in Silicon Valley.[9] Whereas

previously companies were slow to innovate because they had to advance whole systems, now innovation could proceed faster because companies could specialize in particular component technologies. Coupled with the potential for start-up companies funded by venture-capitalists to advance the technology, this has brought competition-through-innovation to a whole range of industries such as computers, electronics, biotechnology, and the Internet.

Various Industrial Segments Are Affected Differently

Although each new competitive strategy is superior where it is applicable, it is not fully applicable to all industries. As shown in figure 2, various segments are affected differently by each industrial transformation, with some existing segments modifying traditional strategies to fit the changed external environment and others (both existing industries and newly emerging ones) fully applying the new competitive strategy.

Changes in How Value is Produced

Competitive Strategies and Industrial Segments

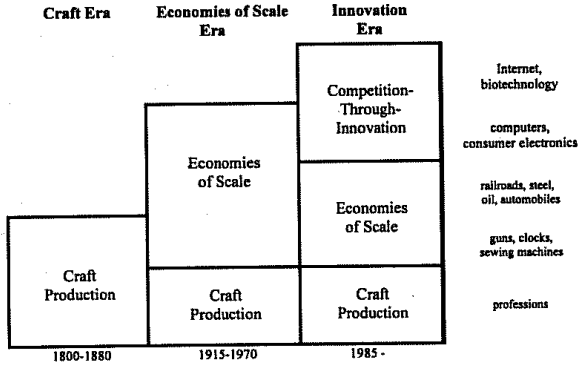

Figure 2

The adoption of a new competitive strategy at the onset of a new industrial stage results in fundamental changes in how economic value is produced. This, not only makes a new value-creating process central to producing economic output, but results in a new class of workers (those essential to the new process) gaining power, influence and prestige at the expense of the previously most valued class.

A. Competition-Through-Economies-of-Scale: Whereas under craft production, the most valued workers were those skilled craftsmen whose knowledge was critical to the production process (the transformation of physical inputs into physical outputs), under competition-through-economies-of-scale, blue-collar workers were less valued, seen as contributing little more than physical labor. During this stage, white-collar workers became the most valued class of workers by using their college-acquired technical and managerial knowledge to increase the efficiency of whole production, distribution

and marketing systems.

B. Competition-Through-Innovation: Today, in those industries in which competi-

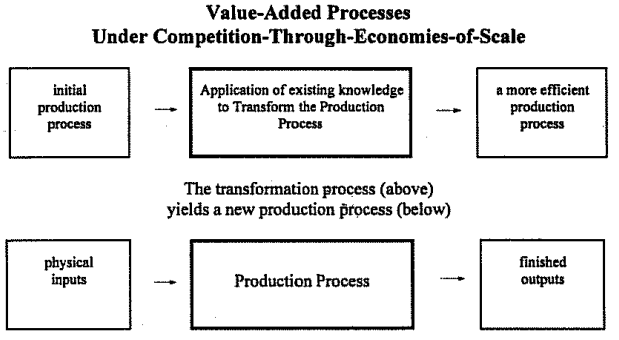

Figure 3

tion-through-innovation is dominant, a third transformation process has been added — the innovation process. Here, a third class of workers, frequently called "knowledge workers" but more appropriately described as innovation workers, generates value, not by using existing knowledge to make the production process more efficient, but by combining a wealth of informal knowledge and experience held by many people and institutions into a steady stream of product and process innovations. Since this innovation process is a synthetic process involving the transformation of *intellectual* resources into yet-to-be-discovered ideas for products and processes, it cannot be reduced to a sequence of routine, bureaucratic steps like the production process. Instead, innovation requires open communication and collaborative learning.

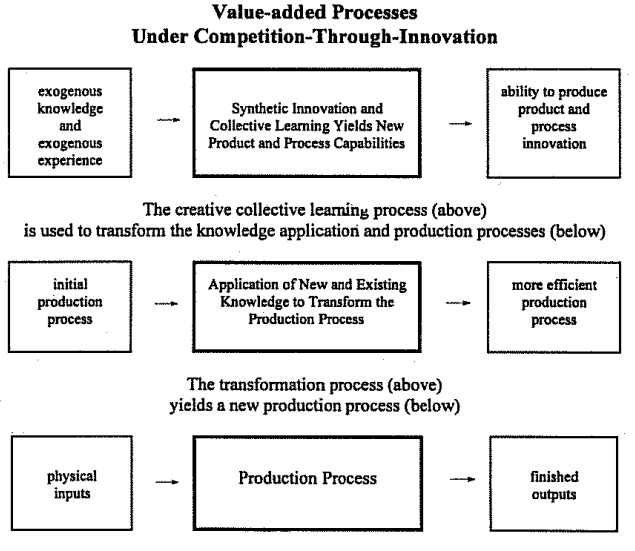

Figure 4

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Changes in Economic Structure

Just as the shift to a new competitive strategy results in a new process for producing economic value, so does it result in structural changes to both firms and the economy as a whole.

A. Competition-Through-Economies-of-Scale:

Before 1850 most firms were family-owned firms with fewer than 50 employees and competition among these firms was rather benign. Companies generally had neither the power nor the interest in crushing their competitors. Similarly, there was little need for large administrative structures since owner-operators with the support of a few foreman could generally supervise people directly.

Once the railroads began their rapid growth in the 1850s and 1860s, this began to change dramatically. On the one hand, there was the Pennsylvania Railroad, which grew from 4,000 employees in 1850 to 30,000 employees by 1865 (making it the largest company in the world). In addition, there were companies like the New York Central Railroad, which resulted from Cornelius Vanderbilt's efforts in consolidating 13 separate railroads and acquiring several others. As railroads manipulated prices for shippers, engaged in conspiracies and fought price wars to gain dominance over one another, competition no longer resembled the ideal market described by theoretical economics but instead came to be dominated by very large and powerful competitors, all using their power and whatever tactics they could to crush their competitors.

In the decades that followed, other industries were similarly transformed. In the 1870s and 1880s, John D. Rockefeller and Andrew Carnegie fought to gain control of oil and steel markets. By 1870, Rockefeller had gained control of 90% of the oil refineries in the country and by 1901, Carnegie had sold his steel company to J.P. Morgan, resulting in U.S. Steel, the world's first billion-dollar corporation. Other industries including electricity generation, cigarettes, meat-packing, and telephones also came to be dominated by oligopolies. Finally, in the 1890s, when a depression caused destructive price wars in other industries that still had numerous competitors, a merger movement was triggered. The result was that by 1904, what had been 5,000 independent firms was reduced to 300 trusts.

B. Competition-Through-Innovation:

Prior to the 1970s, the structure of American industry continued to be dominated by large, vertically-integrated corporations, even in industries such as computers and consumer electronics. Even though innovation had become commonplace in these industries, nevertheless, companies such as RCA, Philco and Motorola continued to assume that whatever innovative products they developed would make it to market ahead of competitors' products. Thus it came as a shock to these companies when Japanese competitors began to both rapidly penetrate these markets with high quality, low cost alternatives and in many cases actually introduce new products ahead of their American competitors. As it turned out, the primary reason that the Japanese were able to bring innovations such as transistor radios, Quasar Color TV's, and VCRs to market more quickly was that they had circumvented the barriers of bureaucracy by using

teams to jointly develop easily-manufactured products instead of allowing designers in one department to create designs that ignored potential manufacturing difficulties. Similarly, when Japanese companies learned to produce higher quality DRAM memory chips faster than their American competitors, it again raised questions about the difficulties of achieving rapid innovation and learning in a bureaucratic environment.

This question was clearly answered a few years later when individual computer companies on Route 128 in Boston were unable to keep up with the pace of innovation set by a network of companies producing computers in the Silicon Valley. Because each Boston company was responsible for advancing the technology of an entire proprietary system, while each Silicon Valley company had only to advance the technology of a particular component within an open system, the Boston companies simply could not keep up.[10] Since that time, the open systems approach utilized by Silicon Valley companies has repeatedly shown itself to be superior in terms of maintaining the most rapid pace of innovation.

Notes

1. Michael J. Piore and Charles F. Sabel, *The Second Industrial Divide* (New York: Basic Books, 1984); Michael H. Best, *The New Competition: Institutions of Industrial Restructuring* (Cambridge, MA: Harvard University Press, 1990); Peter F. Drucker, *Managing for the Future* (New York: Truman Talley Books, 1992); Stephen B. Shepard, "The New Economy: What It Really Means", *Business Week* (November 17, 1997), 38.

2. Piore and Sabel, *The Second Industrial Divide.*

3. James D. Smith, "Strategic Innovation: The Third Industrial Stage" (New York: The New School for Social Research Graduate Faculty of Economics, Ph.D. Dissertation, 2000).

4. Alfred D. Chandler, *Strategy and Structure: Chapters in the History of the American Enterprise* (Cambridge, MA: MIT Press, 1962).

5. Best, *The New Competition.*

6. Thomas K. McCraw, *Prophets of Regulation* (Cambridge, MA: Harvard University Press, 1984); Best, *The New Competition.*

7. Edward J. Nell, ed., *Transformational Growth and the Business Cycle* (New York: Routledge, 1998); Michael Bernstein and David E. Adler, *Understanding American Economic Decline* (Cambridge, England: Cambridge University Press, 1994).

8. David P. Angel, *Restructuring for Innovation* (New York: Guilford Press, 1994).

9. Annalee Saxenian, *Regional Advantage* (Cambridge, MA: Harvard University Press, 1998).

10. Saxenian, *Regional Advantage.*