Title

Corporate Strategy Lessons From the Trade Disaster: You Can't Control What You Can't Produce Competitively

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ABSTRACT

Until executives learn the corporate policy lessons of recent American trade problems, neither can the difficulties of many American companies be unraveled nor the nation's trade deficit be resolved. The erosion of manufacturing capacities lies not in U.S. machines and technology, but in U.S. strategies for automation and the goals American firms seek to achieve through production innovation.

Mass production and administrative hierarchies created the basis for American industrial preeminence in the years after World War II. There is substantial evidence that American firms have been unable to adopt or adapt the model that worked for so many years to the requirements of changing global markets and the production innovations emerging abroad. A sustained weakness in manufacturing capabilities could endanger the technology base of the country just as it has endangered the market positions of so many firms.

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THE END OF AMERICAN INDUSTRIAL DOMINANCE

The Balance Sheet

America's colossal and growing foreign debt -- the balance sheet readout of our compounding trade deficits -- should provoke debate in our corporate boardrooms, not just in our policy councils. American industry has contributed massively to its own undoing.

The fundamental weaknesses in manufacturing capabilities have been at the heart of America's eroding competitiveness and the difficulties of a wide range of firms in diverse industrial sectors. It has not been the unique cause, nor will production development be the single remedy. Macroeconomic difficulties -- feeble savings rates, and a severely overvalued dollar -- played major roles in turning a manageable problem into a national emergency.[1] Macroeconomic solutions are necessary to any sustained improvement, but without a focus on major improvements in the production process, American firms will not be able to reassert their market positions.

Although the exchange rate has been brought back down and better, though not good, numbers sometimes brighten the monthly trade report, we have not solved our problem. Instead, what we have done, at great cost, is to open the possibility of addressing those problems. That window will not stay open very long. Other countries have forfeited the opportunity that a currency devaluation affords. That unhappy fate may be our own. In the early seventies, devaluation rapidly reversed trade flows; the traditional remedy worked. This time, in the late eighties, it has not ad its expected effects. Something big has

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1. Consequently, some economists argue, the problem is fundamentally one of mistaken domestic macroeconomic policy. They contend that the process that created the trade deficits is reversible: reduce the budget deficit, thereby reducing demand for foreign borrowing to finance it; thereby reduce the trade deficit. To us this view is not so much wrong as it is limited and limiting. More importantly, it diverts the corporate community from its responsibility and challenge.

changed.[2] Certainly we have new competitors. The most important are Japan and Asia's newly industrializing countries.[3] Certainly, the currencies of these Asian countries with whom we run major trade deficits have not risen against the dollar to the extent the yen and European currencies have. Yet clearly something new is affecting America's position in the international economy. What is it?

The United States once had dominant positions in product and production: we made products others could not make or could not begin to make competitively. Consequently, high wages and a high dollar did not displace us from markets. That situation has changed. In more technical terms, the price elasticities of American imports have increased.[4]

In the past 2 years the soaring yen has confronted Japan with a currency shock similar to the one we faced in 1981. A comparable percentage rise in the dollar flattened U.S. industrial investment and created massive trade deficits. But despite a doubling of the yen against the dollar, and a set of special emergency measures aimed at increasing imports, the Japanese have increased investment in production and have sustained a trade surplus.

Why are the American and Japanese responses to massive currency movements so different? The contrasting behavior of the two economies in analogous situations suggests

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2. This is a major theme of our recent book, S. Cohen and J. Zysman, Manufacturing Matters: The Myth of the Post-Industrial Economy (Basic Books, New York, 1987). However, more particularly, since 1985, the dollar has lost about half its value against the yen, but the trade deficit has stubbornly refused to follow suit. Only at the end of 1987 was a monthly decline first registered: the deficit fell to $13 billion, itself a record just a few months earlier. Now the monthly deficit has stabilized at about $10 billion a month. Certainly there is some price for the dollar at which imports would dry up and exports explode – if people had confidence that the exchange rate advantage would last.

3. Japan's trade pattern is different from those of other advanced economies, for which intrasectoral trade has been the key to open trade. Japan uniquely has tended not to import in those sectors in which it is a major exporter.

4. Elizabeth Krepp and Jacques Mistral, "Commerce Exterieu Americain: d'ou vient, ou va le deficit?" Economie Prospective Internationale 22, (Paris: Centre d'Etudes Prospectives et d'Informations Internationales, 1985).

the corporate problem: firms in the two nations have shown different capabilities to respond with manufacturing innovation to the challenge of a rising currency.[5]

Japanese producers are succeeding in a situation in which American firms failed. In contrast to the American experience a few years earlier, to compensate for the rapidly rising yen, Japanese firms increased, not decreased, their investment in manufacturing systems to boost productivity gains. We must not lose perspective or exaggerate the situation. Despite the parallel of a rising currency in the two countries, other macroeconomic conditions in the two countries were not the same. The Japanese invested with interest rates at very low levels, while Americans struggled against a rising dollar, high interest rates and recession.[6] Moreover, the Japanese industrial position was improving in global markets in the two decades leading to the period of currency appreciation and firms were able to carve out market shares earlier when the dollar was high relative to the yen. Now, in order to protect those markets, Japanese firms have introduced new products and cut profits to maintain those shares. To be sure, many Japanese firms have lost money in some segments and relocated some production offshore, not only to cheap-labor sites, but also to high-cost sites like the U.S. in order to leap over anticipated import barriers. These moves to cheap labor do not reveal the Japanese long-term response: there is little belief in Japan that moving offshore to produce in a cheaper labor environment is a viable long term solution. Japanese firms are not following the example of American producers; rather than simply seeking to lower the labor bill, they continue to seek to change production itself. The Japanese have shown that they can produce and be innovative in a high-wage location, much as American producers did 30 years ago, and that manufacturing innovation gives them a real

5. See for example, G. Dosi, "Institutions and Markets in a Dynamic World," The Manchester School (in press); K. Pavitt, Res. Policy, 13, 343 (December 1984); N. Rosenberg, Inside the Black Box, (Cambridge University Press, New York, 1982).

6. Thanks to Motisoge Itoh and Yutaka Kosai for pointing this out in response to remarks made at the Nikkei Teleforum

competitive advantage.[7] Yet another view of the trade deficit is that the problem is not one of American firms, which know perfectly well how to produce and compete, but of America as a production location.[8]

The American Model

In the first part of the century, American firms built the model of advanced production. America produced goods, in vast quantities, that other nations simply could not produce competitively. That was the basis of our fabulously high wages, whole number multiples of those paid by our best competitors. What went wrong? How did we fall from our position of leadership?

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7. "Honda Prepares to Survive Yen Rise up to 120 to U.S. Dollar," Jpn Econ. J., 24, 1, 27 December, 1986.

8. The inference, quite at variance with the argument advanced here, is drawn from data on the export performance of American multinational corporations. Between 1966 and 1977 American multinationals increased their share of world exports, maintaining it through 1983 while the American national share dropped.

   There are major problems with the inferences drawn from the data. First, much of the data represents automotives and aeronautics. But despite the high exports automotives generate from various countries, the competitive positions of Ford and General Motors have weakened since 1966. Nor are sales of military aircraft are not the best indicators of economic efficiency. Boeing, the dominant company in commercial aircraft, operates less as an American multinational than as an American domestic producer that exports substantially. This correction aside, America's competitive position in commercial aircraft is weaker now than it was in 1966. Airbus has become a major competitor; Japan is building an aircraft industry, in part as a subcontractor to Boeing, while established European companies and upstart Brazilians produce short-range and specialty craft.

   But most important, in these and other sectors, what does it mean that American multinationals export so much from diverse locations? Those export numbers could be as much a sign of weakness as of strength. They could indicate decisions to manufacture components, subsystems, and even final products in various cheap-labor locations abroad and export them back to the mother company in the United States – perhaps the company has failed to innovate in manufacturing and no longer has the skills to produce competitively in high-wage locations. The U.S. consumer electronics industry exhibited that kind of busy export performance as it was being sliced down by Japanese competitors who operated from a base that included rapidly rising wages, rapidly rising productivity, and a trajectory of innovation in production that proved decisive.

   In sum, inferences drawn from the export performance of American multinational corporations do not undermine our proposal that there is an important link between America's competitiveness problem and our difficulties in manufacturing innovation.

For even a brief answer, we must step back to an earlier period, when firms in the U.S. built their manufacturing capabilities on a set of institutions that developed during a different era of capitalism. Beginning in the early 19th century, with the introduction of interchangeable parts for guns at the Springfield Armory, American firms forged a system of mass production that reorganized capital and labor, and swept away artisan and craft work in many industries. By the time of Henry Ford's moving assembly line for the Model T, the modern mass production system had begun to take hold in a wide range of industries. Coupled with the rise of scientific management, modern mass production generated greater specialization of production and further subdivided labor within the plant.[9] The new system revolved around the management of people, referred to as Taylorism, and control of markets and production strategies, Fordism. The system focused on volume production of standardized products for a relatively homogeneous market. Volume allowed the specialization of tasks, both for machines and for people. The steady increase in specialization and the growth of new functions within the firm such as distribution and marketing eventually resulted in a brilliantly successful new form of enterprise, the hierarchical, divisionalized corporation.

Our manufacturing preeminence was rooted in an particular organization of production and corporate control: mass production and the hierarchical corporation. Innovated in the late 19th century and perfected in the first half of this century, the American system was the most successful management organization the world had ever seen. It won the war; it won the peace. It was the envy of the world. The modern American company emerged after World War II powerful and positioned to dominate the world economy. The system defined the lines along which technological advance would proceed, and technological advances steadily improved the system's performance. Despite new

9. Alfred Chandler, The Visible Hand: The Managerial Revolution in American Business (Cambridge, Mass.: Belknap Press, 1977), Parts III and IV.

technologies and new industries developed during the past 40 years, the basics remain entrenched.

Seemingly suddenly the system froze and became vulnerable to challenges that were to emerge abroad. Why did the system congeal? First, of course, because it not only worked, but it worked better than anything that came before it anywhere. And it was improving steadily. There were several secondary reasons for its stubborn stability. A great many dominant industries such as automobiles, and steel had become stable oligopolies with mature, sluggishly increasing demand and high barriers to entry. These structures diverted competition from basic change in production or technology into marginal changes in product, price and style. Also, a set of institutions and social relations grew up as part of the system. Elaborate systems of labor relations, with growing and increasingly strong unions, through business schools (a product of this period) and comparably complex systems of management training, organization methods, and incentive structures developed. Changing approaches to production would mean changing these social institutions and relations. The mass production paradigm was not going to change without the shock of innovations from abroad. That shock took a long generation to come; when it hit, it hit hard.

INNOVATION FROM ABROAD

After the war everyone -- the Japanese, the French, the Germans -- set out to copy the American model and catch up with their future. What actually happened was not so much faithful copies, but something quite different. New forms of advanced production emerged in radically different environments. These innovations in production have substantially changed the terms of competition, and introduced new models that accelerate product cycle-time, heighten product differenttation, and favor economies of scope and flexibility over traditional economies of scale. These innovations began as small adaptations of traditional production methods, tailoring business practices to constraints, strengths and social institutions in those nations. They do not so much encompass radically new tools or automated lines as much as a reorganization of ideas, people and production methods.

Two innovations from abroad made the difference in the terms and character of international competition. The first is the new and active role of the state in systematically developing industry and in seeking to directly change the structure of the nation's comparative advantage. As mentioned above, Japan is the premier example, but not the only case.[10] Here, the government instituted a set of policies to promote investment over consumption, target strategic industrial sectors through state-steered financing and, crucially, protect domestic producers from foreign competition.

The second form of innovation is the present focus of our attention. It is the transformation of the manufacturing process itself into a source of advantage. The emblematics of the production innovations are carried by code words such as "flexibility", "just in time", and "total quality." These both suggest and obscure concrete changes in the

10. For the role of institutions and economic development in Japan, see Chalmers Johnson, MITI and the Japanese Miracle: The Growth of Industrial Policy, 1925-1975 (Stanford, Calif.: Stanford University Press, 1982).

way goods are designed and produced. In the best firms these innovations extended well beyond the shop floor to the nature of the product, beginning with a design concern for manufacturability and extending to a corporate decision process in which anticipated economies of scope can justify investments in new technologies. These investments are difficult to justify using more traditional criteria, but they figure prominently in the firm's strategic positioning against its competitors. Let us look at this more carefully.

Flexibility in Manufacturing

As basic approaches to manufacturing change, an effort is being made to create the concepts and language to examine and discuss these changes. Flexibility is the code word.[11] Traditional mass production is inherently rigid. It rests on volume production of standard products or components with specialized machines dedicated to specific tasks. Now the principle is to apply a set of more general-purpose tools to produce a greater range of products. Importantly, the bulk of manufacturing has involved batch production that was difficult to automate. New approaches and programmable equipment open batch production to increased automation, and reduce some of the cost difference between batch and series production.

Flexibility, a firm's ability to vary what it produces, rests on organization. The same machines can be used in rigid or flexible automation. Technology itself is channeled and formed by the conceptions of those who would use it. However, flexibility is an imprecise objective as much as a description, and has come to mean not one, but a variety, of ways to

11. See, for example, A. Sayer, "New developments in manufacturing and their spatial implications" (Working paper 49, University of Sussex, Urban and Regional Studies, October 1985); M. Piore and C. Sabel, The Second Industrial Divide: Possibilities for Prosperity (Basic Books, New York, 1984). B. Coriat, Automatisation Programmable et Produits Differencies CERTTD Conference (GERTTD, Paris, 1986); "Information, Technologies, Productivity, and New Job Content," paper presented at a BRIE conference Production Reorganization in a Changing World, Berkeley, CA, 10-12 September, 1987; B. Coriat and R. Boyer, "Technical Flexibility and Macro-Stabilization," paper presented to the Venice Conference on Innovation, Diffusion, Venice, Italy, 2-4 April, 1986.

adjust company operations to shifting market conditions. Static flexibility suggests that a firm has the ability to adjust operations at any moment to changes in the mix of products the market is demanding: If one product is not selling, can production be oriented quickly to another? It implies adjustment within the confines of established products and a fixed production structure. This notion is captured in the distinction between economies of scale and economies of scope. Economies of scale is the notion that the cost of producing a single unit declines as volume increases. Economies of scope are gained not in the volume production of a single good, but in the volume production of a set of goods.[12] Scope and scale often move together: large-scale plants may be required to realize flexibility. The advantages of scale do not disappear. Very expensive production lines make possible the volume production of a variety of products. In some industries, such as semiconductors, the cost of a basic production line has risen steadily even while application and user specific products have become possible. Economies of scope are created by standardizing processes to manufacture a variety of products.

Dynamic flexibility, in contrast to static flexibility, means the ability to increase productivity through improvements in production processes and product innovation. The ability to change quickly in response to product or production technology -- to put ideas into action quickly -- is the central notion. In a period when automation technologies permit new production strategies, dynamic flexibility is crucial.[13] Yet as Jaikumar has pointed out, making flexibility and responsiveness the mission of manufacturing "flies in the face of Taylor's view of the world which for 75 years has shaped thinking about manufacturing."[14]

12. J. D. Goldhar and M. Jelinek, Harvard Bus. Rev., 61, 141 (November/December 1983).
13. B. Klein, "Dynamic Competition and Productivity Advances," in R. Landau and N. Rosenberg, eds., Positive Sum Strategy: Harnessing Technology for Economic Growth (National Academy Press, Washington D.C., 1986).
14. R. Jaikumar, "Postindustrial Manufacturing," Harvard Bus. Rev., 64, 69 (November/December 1986).

Production in Japan and Italy

Let us look at two images of flexible production that break from traditional practice, one we associate with Japan and the other with Italy. The important outcome in each case is that the relation between production and corporate strategy is altered. Manufacturing becomes a competitive weapon, an instrument of a new approach to strategy.

The first is a new approach to high-volume production. Let us call this flexible velocity manufacturing.[15] For some, the picture of Japan is the high-volume, automated factory operating through the night with no lights and no workers. The Japanese are not simply copying American production with less expensive capital, or even pushing the American model of mass production to its logical conclusion and simply lowering costs. Something quite different is happening. For example, as part of a general reorganization of production, Japanese producers have reduced inventories and improved materials flows as well as altering quality control processes and substantially reducing labor content. Velocity in our phrase refers to a range of capacities, from the ability to rapidly pull materials through the production process, reducing the time that parts and products are held to the ability to move rapidly from initial product idea to market.

Flexibility in the production systems has permitted new products to be rapidly introduced and constantly improved and adapted. Honda defended its market position in motorcycles in Japan by abruptly introducing an entire new product line. Japanese automobile producers have substantially benefitted from their advantage in cycle-time -- from design to production -- over their American competitors.[16] American producers, in contrast, typically do not make production innovations incrementally. They tend to jump

15. Our thanks to the IBM corporation presentations for this phrase. This notion corresponds to the reasoning of Benjamin Coriat.

16. J. C. Abbeglen and G. Stalk, Jr., Kaisha: The Japanese Corporation (Basic Books, New York, 1985), p. 80.

from one production plateau to another; change is slower and more risky.[17] Japan's flexibility has developed from continuous production innovation, often with internal design of equipment, and a skilled workforce able to understand and implement the continuous changes. Advanced production technologies are not an alternative to skilled workers. It is the capacity to manage the continuous evolution of the production system, and not merely the ability to operate an automated factory, that is the competitive meaning of post-industrial manufacturing. In our view, this notion of "flexible velocity" production is the dominant form of the new production, evident at Fiat as well as IBM and Seiko.

There is, though, a second important image of production innovation: flexible specialization. In Italy and Germany, networks of small firms have developed this approach to innovative production organization.[18] Using modified traditional technologies, communities of small firms have established themselves as world-class producers in sectors such as textiles, apparel, and machine tools. These horizontal networks involve shifting combinations of cooperation and competition, with today's collaborators being tomorrow's competitors. Success has been built on a base of traditional craft-like skills. The Italian firm, Marpos, has built up its $300 million dollar business with a substantial position in the Japanese market from a base of skills in metal grinding. Comau, another Italian firm, with a turnover of over 700 million dollars, sells vehicle factories and production equipment, including robots, to Saab, GM, and Chrysler, as well as its parent Fiat. Its success is built on a knowledge of automobile assembly and production process. Benetton grew up from a

17. S. Wheelright and R. M. Hayes, Restoring Our Competitive Edge: Competing Through Manufactures (Wiley, New York, 1984).

18. Charles F. Sabel, Work and Politics: the Division of Labor in Industry (New York: Cambridge University Press, 1982); Michael J. Piore and Charles F. Sabel, The Second Industrial Divide: Possibilities for Prosperity (New York: Basic Books, 1984). Sabel and Piore have helped develop and popularized the notion of flexible specialization organized around communities of craft skills. Much of their work draws on the experience of Italy. Students working with them have shown similar phenomena in Germany and Japan. See Gary B. Herrigel, "Industrial Order and the Politics of Industrial Change: Mechanical Engineering in the Federal Republic of Germany" Cambridge March 14, 1988;

factory-floor knowledge of machinery, though it now buys outside its telecommunications systems.[19] All three of these firms were launched as small, almost family firms on the strength of the traditional craft-like skill of the entrepreneur. They specialized in the task they understood and they were flexible as to the role they played in the market. Indeed many of these firms have incorporated advanced electronics technology into the traditional activity of which they have mastered, often through creative trade association activity. Flexibility is suggested by the exceptional willingness to adapt equipment, including the electronic interfaces, to the needs of clients. Their specialization is suggested by their insistence that market position is built on a distinct knowledge of some piece of the production process.

Flexible velocity, rooted in modifications of volume production in larger firms, and flexible specialization, with its origins in smaller craft-based companies, differ greatly from one another. Yet they share some common features. One of these is to limit inventories. The need for inventories is radically reduced, not just because some inventories are pushed back to suppliers, but because all producers in the chain learn to modify production to limit their own inventory needs. A second common element is a network of small suppliers tied to common tasks by market relations and direct hands-on contact rather than by administration and bureaucracy. Those fluid networks give flexibility to small and large companies alike. Some of the networks are vertical, with tiers of suppliers linked to large firms such as Fiat and Benetton in Italy or Toyota in Japan. Others are horizontal networks. These networks, these steps toward vertical disintegration of production, were not created deliberately. Rather, in Japan and Italy hordes of small producers survived, in part through political protection, into the late 20th century. As a result, small firms account for more manufacturing in Japan and Italy than in other advanced countries. The networked system was created as producers, large and small, sought ways of competing in

19. F. Belussi, "Innovation in Production: The Benetton Case," (BRIE Working Paper 19, BRIE, University of California, Berkeley, March 1986).

national and global markets in the 20th century. The pattern differed from that established under American conditions. The networks proved more flexible, and resolved problems that traditional administrative integration could not.[20]

Rapid expansion in Japan, and in a less steady way in Italy, permitted capital investment and the introduction of new machines. And the effort to catch up to more established technologies forced iterative production innovation. Introducing new machines opens the possibility of production reorganization, but does not ensure it.[21] Nor do new production systems ensure increased productivity. Indeed, new production systems rarely function perfectly when first introduced, and they may actually lower productivity initially. Yet rapid growth generated not only investment in new machines, but also new approaches to manufacturing, new organizations to implement them, and new strategies to gain advantage from them.[22] The innovations that initially were ways of competing in a world in which America's allies were laggards unexpectedly became the basis of advantage.

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20. Some discuss these changes in terms of an historical shift in production. Although most production has always been done in batches, the prevalence of mass production has prompted the placement of technical issues in historical context. Henry Ford's assembly line became Fordism – a type of mass production, and simultaneously, a social organization of production. Subsequent developments reverting to batch production have been labeled post-Fordist, or using general purpose tools to produce a variety of products. Some contend that this technological shift will reorganize the structure of firms in an economy to favor smaller firms competing in market niches over large firms in mass markets. There is, however, nothing in the notion of dynamic flexibility that negates scale economies, especially the advantages of size in marketing, financial staying power, and the capacity to invest in expensive machinery. A new romanticism focusing on small firms is not necessarily prudent. We must remember that Matsushita and Seiko are leaders in both flexibility and scale. Nothing of course is certain. But in today's environment, firms rooted in a social organization of production of the past are finding it increasingly difficult to compete.

21. This is emphasized in Wheelright and Hayes, Restoring Our Competitive Edge, op. cit. Often the introduction of new technology leads to a drop in productivity levels. Only when the reorganization is effective are the potentials of new equipment captured. Our view is that when equipment is crafted in-house to fit the needs of organization developed on the shop floor, the disruption is limited or nonexistent.

22. Y. Murakami and K. Yamamura, in Policy and Trade Issues: American and Japanese Perspectives, K. Yamamura, ed. (Univ. of Washington, Seattle, 1982), pp. 115-116.

HAVE AMERICAN PRODUCERS ADJUSTED?

Is American industry exploring the new approaches to production and capturing the possibilities for flexibility new technologies, or is it caught in an increasingly obsolete production paradigm? There are journal articles and awards for flexibility, and some firms certainly are moving in that direction. Yet there is substantial evidence of a problem, evidenced in several forms. The first piece of evidence is a large set of industry and firm case studies of international competition and production organization. These cases are more than anecdotes, for taken together they represent a substantial share of the economy and tell a consistent story, a story of slow and partial adjustment. In steel, American firms import from Japan production know-how that was based on an earlier Austrian innovation. In automobiles, American firms struggle to match the cost and quality performance that has enabled Japanese firms to capture a large, permanent share of the American market. In both sectors, the recent drop in the dollar's value has closed the gap in final costs, but has not placed American firms on a competitive trajectory of technology development.

The semiconductor industry recently was shocked to discover that its seeming technological advantage was vulnerable to production developments in Japan. The production tools that embody know-how and innovation -- machine tools in metal bending industries, automatic looms and jet spinners in textiles, photolithographic and ion implantation equipment in semiconductors -- increasingly are imported. One offshore producer of apparel argues that, on paper, the economics permit him to bring production back to the United States, but the required skills and infrastructure no longer exist. Ironically, they can be found in cheap-labor locations; skills developed where American firms transferred their production.

This is the second issue. It is not simply that a set of firms or sectors are in difficulty, but that the infrastructure of production know-how has weakened. There is simply a wide range of arenas where the know-how and the equipment development are gone.

Third, and very importantly, the ways America uses advanced technologies seem to differ from the ways our best competitors use them and the advanced technologies for innovative production do not appear to diffuse as widely in the United States. A study published in the Harvard Business Review demonstrated concretely the contention that American firms do not capture the full potential of new technologies: rather than creating flexible systems, they implemented new technologies in traditional ways.[23] Comparing both Japanese and U.S. flexible manufacturing systems (FMS), the author found that for making comparable products, the Japanese and American firms used almost the same number of tools -- six in Japan, seven in the U.S. From those tools, however, the Japanese made an average of 93 parts, compared to 10 in the U.S., while the average volume per part in the U.S. was 1,727 against only 258 in Japan. The American firms essentially applied the new flexible tools to their old inflexible style of manufacturing, while the Japanese used the tools to develop and produce a flexible range of products. The author concluded that the use of FMS in the U.S. showed a basic lack of flexibility in use.[24] The American firms used the new tools to improve economies of scale -- lowering the cost of production through increasing output -- while the Japanese increased production and efficiency through economies of scope -- increasing production in a range of goods.

A related issue is the diffusion of advanced technology. Arcangeli *et al.* examined the introduction of advanced automation technology into factories in advanced countries.[25]

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23. Jay Jaikumar, "Postindustrial Manufacturing," op. cit.
24. Ibid., p. 69.
25. F. Arcangeli, G. Dosi, M. Moggi, "Patterns of Diffusion of Electronics Technologies," paper prepared for the Conference on Programmable Automation and New Work Models, Paris, 2-4 April, 1987.

Their techniques and data sought to separate advanced from traditional manufacturing investments. They concluded that the United States leads the way in office automation, but trails in factory automation. America invests more in traditional automation and less in flexible manufacturing than do other advanced industrializing countries. The pace at which advanced technologies are introduced is slow -- that is, only a small percentage of firms use such things as flexible manufacturing systems. Yet those American firms that use these advanced technologies and use them well tend to be leaders in their sectors. Numerically controlled machine tools and the advanced programming languages to incorporate them emerged early in the United States, as did the technology and use of robots. However, as is widely known, they are used much more extensively in Japan than in the United States; diffusion is several times broader, with some 40% of the machines in smaller firms. The evidence is powerful. Aggregate trends reinforce factory and sector studies. The argument that there is a problem in the evolution of American manufacturing is now strong enough to require refutation rather than further demonstrations.

The Myths that Impeded American Adjustment

The American response to the pressure of innovations from abroad, not the innovations themselves, has been the problem. At the core, we propose that American difficulties in maintaining manufacturing position and skills and in sustaining production innovation lie not in our machines and technology, but in organizations and the use of people in production, in the strategies for automation and the goals we attempt to achieve with production innovation. The problem is not with our robots or our local area networks, but with our understanding of how to exploit their productive promise: The problem is with corporate strategy.

Two sets of powerful myths impeded our understanding of the evolving world economy and the choices confronting the nation and our corporations.

The first set of myths are popular and policy myths. That mastery and control of manufacturing was critical to the nation's continued economic development and to the continued competitiveness of American firms was obscured by a popular myth that sees economic development as a process of sectoral succession. It was widely believed that economies develop as they shift out of sunset industries into sunrise sectors. For example, agriculture is followed by industry, which in turn is sloughed off to less developed places as the economy moves on to services and high technology. Simply put, this is incorrect. It is incorrect as history and it is incorrect as policy prescription. America did not shift out of agriculture or move it offshore. We automated it; we shifted labor out and substituted massive amounts of capital, technology, and education to increase output. Critically, many of the high-value-added service jobs we are told will substitute for industrial activity are not substitutes, they are complements. Lose industry and you will lose, not develop, those complementary service activities. These services are tightly linked to production just as in the case of the crop duster (in employment statistics a service worker) who is tightly linked to agriculture. If the farm moves offshore, the crop duster does too, as does the large-animal vet.

Similar sets of tight linkages -- but at vastly greater scale -- tie "service" jobs to mastery and control of production. Many high-value-added service activities are functional extensions of an ever more elaborate division of labor in production. The shift we are experiencing is not from an industrial economy to a post-industrial economy, but rather to a new kind of industrial economy. These general formulations undoubtedly affect the notions and philosophies of American corporations; they certainly affect the policy environment in which these companies must operate.

As we talked of Sunrise and Sunset industries, we looked to Route 128 and Silicon Valley as if they were our national future, and the steel and automobile plants of the Middle West as if they were our national past. Yet we ignored the fact that Americans don't buy

micro-chips or mini-computers, but rather the products designed with, around, and by them. Microelectronics, biotechnology, and new materials are all transformative technologies; their applications change the nature and character of so-called traditional sectors. Success in those sectors, as the incorporation of microelecuronics in European capital equipment sectors suggests, still depends on basic knowledge of the traditional processes.

More important in this discussion, there has also been a devastating set of corporate myths that have more directly distorted the adjustment of American industry. The set of corporate myths is extensive, here we examine three interconnected ones: first, that a firm can win with a technology edge alone. (In a different analyses we would emphasize the myth that one can win primarily with financial controls and management, that the industrial corporation is really an investment portfolio not a complex of skills and know-how); second, that low-cost labor can sustain a production position; and third, that the cost of capital is the central obstacle to production innovation. Together these myths have prevented American firms from understanding developments in the world economy, from identifying the importance of production in corporate strategy and the importance of skills and organization in production, and from acting on their understanding.

The **first** of the connected corporate myths is that breakthrough product technology can provide an advantage that is sufficient to maintain a position in the market and that a firm can consistently defend products at the top end of the market without defending the broader range of products. Certainly, breakthrough product technology, like the hand-held calculator, the video tape recorder, and the personal computer, can create real personal fortunes and initial market entry. However, the initial position is hard to defend if it isn't entrenched in competitive manufacturing skills. The magnetic disk drive industry is an evident example where firms with breakthrough products lost position to firms with stronger production technologies. In the case of Shugart, for example, the firm self-consciously

disdained production, and found itself battered by the Japanese firms it had licensed.[26] But this is not the only example. Television producers sought to defend the high-value, top-end color televisions and ignored the lower value black and white televisions that were being made from different components: transistors, not tubes. The list of examples is long, but the issue is a general one.

For a firm, production capability is a decisive competitive tool. It is not just a question of marginal cost advantages: a firm cannot control what it cannot produce competitively. In the end, product knowledge and production knowledge do not exist separately. The steady series of innovations required to defend even a new product are intertwined with the knowledge of how the good is produced. There is little chance of compensating for production weakness by seeking enduring technological advantage. The capacity of firms with production know-how to imitate or redesign an established product is enormous. The diminished cycle-time for new products is not a warning to abandon production but to defend production to lengthen the time before a competitor can effectively establish market position. Ceding the bottom end of the market simply allows a competitor to establish market presence to attack the top end. A production disadvantage can quickly erode a firm's technological advantage. Only by capturing the "rent" on an innovation through volume sales of a product can a company amortize its R&D costs or justify investment in R&D for the next-generation product. The feeble American presence in next-generation consumer electronics indicates the cost of failure to produce competitively in the previous generation. Finally, if a firm simply tries to sell a laboratory product to someone else who will produce it, the value of the design is lower than that of a prototype, and prototypes are valued lower than products having established markets: each step toward the market decreases uncertainty. A producer with a strong market position often can buy a

26. Cohen and Zysman, Manufacturing Matters, op. cit. See also M. Borrus, Competing for Control: America's Stake in Microelectronics (Ballinger, Cambridge, MA, 1988).

portfolio of technologies at a low price and capture the technology rents through volume sales. For the firm, manufacturing matters.

The **second myth** is the notion that foreign cost advantage lay with cheap labor. In the late 1960s and early 1970s, American firms faced with foreign competition often concluded that their rivals used low-cost labor to achieve competitive advantage. The response was to seek even cheaper labor -- offshore. Few firms realized that innovations in production, usually achieved with limited technological advance and considerable organizational imagination, were occurring. As a competitive strategy, relocating production offshore proved to be the wrong solution to the wrong problem derived from the wrong analysis. It assumed that the competitive problem was direct labor costs and attacked at that point. But labor costs were only one element -- and a rapidly shrinking one -- of the Japanese advantage. Indeed in many of the industries that ran offshore for cheap labor, direct labor was a small and shrinking proportion of cost, and has fallen as low as 8-12% today.[27] As many producers were to realize soon, but nonetheless, too late, the Japanese advantage hinged increasingly on production organization and decreasingly on low-wage labor. In the 1960s Japanese producers used more labor hours to build a television than their American competitors, and consequently advantage lay with low labor costs. By the 1970sthe Japanese used fewer labor hours, winning with production organization.

The American consumer electronics industry was an important leader in this downward direction, offshoring production, lobbying successfully for special legislation to protect its re-imports, and blinding themselves to the reality of their competitive problem until a dominant industry was effectively wiped out. For as American firms shifted production to low-wage sites in Asia and Latin America, they accelerated their own downward spiral. The cheap-labor solution permitted them to ignore the need to rethink their production organization; it bought time. And during this period, the industry failed to

27. James A. Brimson, "Bringing Cost Management Up to Date," Manufacturing Engineering, June 1988.

fashion its long-term competitive response, while the Japanese gained an irreversible competitive advantage. This strategic debacle affected not only the consumer electronics industry, but a broad set of other industries such as semiconductors. The Japanese wrested dominance in consumer electronics, and used it as the key to the mastery of volume production in semiconductors. Offshoring reduced the manufacturing infrastructure of the U.S. not only by relocating jobs overseas, but by helping to develop systems of suppliers, subcontractors, and technology transfer to the overseas locations. Moves offshore could, at best, achieve a one-time reduction in costs; they did not permit the steady innovation in production processes required to keep pace with moving production targets.

In losing control of production, American firms also lost control of product development and were unable to exploit the VCR revolution as it emerged. A similar story is being written for the semiconductor industry, where Japanese production advantages have levered them into an increasingly powerful position that threatens American strengths in development and design. Innovation in production has proved to be as critical as innovation in product; it has in fact proved necessary for product innovation.

When firms at last began to rethink production strategies, their efforts often foundered on a **third myth**. The myth circled around the cost of capital. High capital costs undoubtedly represent a handicap for production reorganization, but it is not the central source of American problems. Undoubtedly, less expensive industrial capital is better than more expensive capital. Undoubtedly, easy access to substantial long term funds facilitates strategies of production development. Certainly, Japanese financial structures and policy facilitated long term inexpensive capital. However, the question is what to do with that capital. As we saw earlier, American firms -- taken as a group, for there are certainly exceptions -- have not been implementing the most advanced production strategies, and have paid the price. In our best competitor countries, but especially in Japan, rapid industrial growth and low-cost capital afforded firms the opportunity to invest in new

machines and new production methods. But the introduction of a new machine does not necessarily guarantee productivity gains. Installing new machines must be the second part of the strategy; reorganization of production must come first if the machines are to live up to their potential. In many American companies the machines were installed, often at colossal expense, but the painful organizational questions were sidestepped. General Motors spent "more on automation than the gross national product of many countries,"[28] but the benefits have yet to be realized. In contrast, GM's joint venture with Toyota, the NUMMI plant in Fremont, California, is one of GM's most productive plants; the plant's success stems from its changed labor relations and reorganization of production on the line, rather than the implementation of the most automated equipment.[29]

What is to be Done?

The priorities and prescriptions of the past years have led to industrial decline. Certainly, there are no precise guidelines for the adjustments that are required and the complex set of corporate decisions and battles that will make those adjustments possible. We propose not a list of actions to be taken but a philosophy that production, in the broadest sense, is a strategic issue.

First, production is a strategic weapon, a basic instrument of corporate strategy. Systems of corporate control and accounting must be structured to utilize, not blunt, that instrument. Accounting can only count what it is told and make prescriptions based on the implicit accounting logic. Concretely, that suggests such things as altering how overhead is handled and how material holding and handling costs are analyzed. Unless properly treated, accounting procedures can lead to outrageously perverse consequences. In the past

28. Stephen G. Payne, quoted in "The Productivity Paradox," Business Week, June 6, 1988, p. 100.
29. See Lowell Turner, "NUMMI In Context: A Comparative Perspective on the Politics of Work Reorganization in the U.S. Auto Industry," Paper presented at the Western Political Science Association, 10-12 March 1988, San Francisco, California.

we have counted to an old logic, judged by an old logic, and often lost by that old logic. Now we must develop a new logic, and learn to count according to that logic.

Second, strategic assets of production know-how and skills must be defended and strengthened, not traded away. The reasons are multifold, but at the core, production skills and command of the production process are tied to the capacity to develop new products and get them to market. Sourcing outside simply teaches competitors or potential competitors how to produce, gives established producers greater volumes and greater production expertise, and creates potential dependencies. Indeed, in the name of defending markets by sourcing outside, a firm risks becoming a simple distributor.

Defending production capacity means producing -- not sourcing -- critical products and components. This is not an argument for extended vertical integration. Indeed, the Japanese and Italian experience point to an effective disintegration of the production chain. The terms and the logic of production decisions are critical; the decision whether to make or buy an intermediate product is a crucial and often fatal one.

Third, a commitment to continuing development in production technologies is indispensable to the advanced countries. Many American firms and industries are attempting to produce more flexibly. Unfortunately, the purposes of automation and the organization suited to capture the advantages of new technologies have not been worked out; thus new technologies may not be introduced -- or when introduced, have limited impct. The era of static, mass production has not ended, but shifting to more flexible production has proved to help firms' competitiveness. Evolving the production technology must mean, among other things, developing real flexibility in production.

Mass production is not only inherently static, it has social inertia; American business schools and corporate practices cling to static, quantitative methodologies that emerged to support the mass production approach. The risk is that the social inertia of existing arrangements locks American producers into reinforcing rather than replacing

existing production systems. And management thus pushes itself toward quick fix solutions. But quick fixes -- such as moving production to low-wage sites -- are just that, quick fixes. Previously, when mass production competed with artisanal and batch production its static approach did not matter; its revolutionary power obscured the problem; the efficiency advantage was overwhelming. Today, however, the greater uncertainty in markets and technology rewards flexibility in manufacturing rather than static approaches.

Sustained production development and long-term flexibility can be built only around skilled workforces and a thorough rethinking of production organization. Technological development must build on, not replace skills. Higher levels of education of the shopfloor workforce in Japan account for higher productivity levels and distinct production approaches. American industrialization rested on a literate but "semi-skilled" workforce. Many American firms, in an effort to control labor costs or adopt unnecessary automation, have stripped the educated and skilled labor out of the production process. By contrast, real worker skills, communities of skilled workers, and education strategies have permitted strategies of flexibility and specialization in Italian and German equipment companies. People and organization, not machines, are the key.

American firms must decide whether they want to be design houses, system integrators, and distributors -- positions that can ultimately be replaced -- or real industrial companies. Certainly we must have design houses, system integrators, and distributors, but even those roles cannot endure if we are designing for production abroad and integrating and distributing equipment developed and produced outside this country. How firms deal with the problem of developing and maintaining manufacturing skills will tell the tale. The stakes are not simply corporate success, but the wealth and power of this country.