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This paper is designed to provide a framework for considering state government policies to encourage modernization among small and medium-sized manufacturing companies. It is also aimed at promoting a review of state policies and programs for helping to train workers and managers of manufacturing concerns. The report synthesizes what we think we know about these matters, challenges a few generally accepted notions, and offers recommendations for improving state economic development efforts.

Some topics are addressed only in a summary fashion, assuming that most readers have a general familiarity with economic development issues at the state government level. Readers are also assumed to have a passing acquaintance with many of the principal issues of technology development, finance, education, and training as they relate to the manufacturing sector.

There is no discussion in this paper of industrial policy at the federal level. It is assumed that whatever the federal government now does or does not do, it will not change. That assumption seems safe. The focus here is on the strategic choices that face state governments.

The first section summarizes some of the reasons why this is an important issue. The second offers some context—a way to understand the economic changes that American manufacturers are confronting. The third, fourth, and fifth sections discuss some of the principal issues of technology, capital, and human resources, respectively, that are caught up in the competitive problems of American manufacturing firms. The sixth section outlines some basic goals and principles that
should lie at the foundation of efforts to build a strategy. The final section recommends some key elements in fashioning a comprehensive strategy for modernizing America’s small and medium-sized manufacturing establishments.

The Problem of Manufacturing Modernization

In the past few years, a consensus has begun to form around the notion that America’s industrial base is in trouble. Our manufactured products are not competing well in international markets. Persistently high deficits in the merchandise trade balance can no longer be blamed on an overvalued dollar. When the dollar declined in the middle of the 1980s, the deficits decreased, but not by very much, and they most certainly did not go away.

The trade deficits are dangerous for what they imply—a weakening industrial sector—and for what they will bring about—a skid in the standard of living in the United States relative to other countries. There is some evidence that such a skid is already underway. The trade deficits cannot be attributed simply to unfair trading practices by our chief competitors. Consumers right here in America have been making the same judgment as consumers in other nations; in several key industries, they prefer foreign-made goods to those made domestically.

Average annual productivity growth in the United States has lagged well behind that of Japan and somewhat behind that of several European nations for the past several years. While it is true that those economies had been growing from a lower base, it is nonetheless clear that the relative productivity growth of those nations has translated into increasing market share and a rising standard of living relative to the United States.

Macro indicators of slow relative productivity growth do not always tell the whole story and can be subject to varying interpretations. However, these macro indicators tend to be borne out by direct observation. Anyone who has recently visited and compared manufacturing establishments in America, Japan, and Germany cannot fail to be deeply
impressed by visible differences in the level of technology, the skills of workers, the strength of management systems, and the quality of final product. Most American plants lag behind.

This is not to suggest that there are no “best-practice” manufacturing firms in America. Indeed, in virtually every industrial sector, there are high-performing firms in America who can consistently compete at the front edge of the market with any firm anywhere in the world. Our problem is not one of best practice; it is one of common practice. Our common-practice manufacturing establishments tend to lag well behind the industry leaders. That common-practice gap appears far wider in America than in several nations of the Pacific Rim and Western Europe. The gap is most observable at the high end of the market where higher level technology and higher level skills produce the highest value-added products.

As illustration of this, several major industries that have been very important to the American economy have lost major market share in the United States and in foreign markets to competitors from other nations. Automobiles, steel, machine tools, footwear, textiles, and apparel are examples of old-line industries that have suffered in international competition, especially at the high end of the market. Consumer electronics has virtually disappeared in the face of intense global competition.

Several newer, technology-intensive industries are also suffering an erosion of global market share. Telecommunications, semiconductors, computers, and pharmaceuticals all have lost ground in the past few years. This erosion of competitive position is costing us jobs. Manufacturing employment has dropped sharply in America during the past several years. Some of that job loss came from the introduction of automation technology during the 1970s and 1980s; some can be attributed to the restructuring of major industries during the latter half of the 1980s. But a good deal of the job loss in manufacturing has been the result of the loss of competitiveness and market share of many American manufacturers.

There is evidence that the persistent competitive problems of American manufacturing have affected the standard of living of workers in
this sector. Average wages in manufacturing are not growing as rapidly here as in Europe and the Far East. While the average American family's income shows little change in the past decade, there have been changes in the distribution of that income. Only in the top 20 percent of family income were there increases in the period 1977 to 1988. In each decile of the lower 80 percent, family income declined over the 12 years; the lower the income, the greater the decline (see Office of Technology Assessment (OTA) 1990).

We cannot look to the growth on the service side of the economy to offset our industrial decline. The export of services represents a small fraction (10 to 12 percent) of the total value of goods and services that are imported. Total exports of services are an even smaller fraction of the total value of manufacturing purchased in the United States from both domestic and foreign sources. Any notion that America can even come close to offsetting its deficit in merchandise trade by increasing the export of services is fantasy.

The employment shift away from manufacturing tends to be overstated. The apparent shift does not account for the statistical reclassification of large numbers of American workers. Many of these workers perform in what now is classified as a service establishment (because it has been separated from the production facility) the same functions they used to perform as manufacturing employees in the old production establishment. Others perform under contract as service workers the same tasks that used to be provided by direct employees classified as manufacturing workers.

Manufacturing is important to the economic health of America. It continues to supply almost as much of our national income now (about one-fourth) as it did 20 or even 30 years ago. Manufacturing buys as inputs, according to some estimates, about 17 percent of the outputs of the services sector. It is essential to our national defense.

The issue, as posed by the MIT Commission on Industrial Productivity (1989), is not whether America will be a manufacturing nation, but rather if it will compete as a low-wage manufacturer or a high-productivity producer.
The competitive arena will not become easier for American manufacturers in the years ahead. Japanese manufacturing companies show no evidence of forgetting about continuous product improvement or slowing their efforts to increase market share. Other Pacific Rim nations are increasing their industrial productivity by applying Japanese practices and producing skilled workers. The emergence of a unified market in Western Europe, the economic unification of Germany, and the opening of Eastern and Central European markets will further accelerate already impressive economic gains of several European nations.

American manufacturers can also look forward to a gradual deterioration in what has been their largest and safest market over the past several years—the Department of Defense. By some estimates, Defense purchases over 20 percent of the gross product of American manufacturers. Its purchases from high-tech firms are estimated at one-third of the gross product of those industries. While it is difficult to estimate very accurately how political/security needs in the years ahead will affect military spending, it is probably safe to assume some significant reduction in growth. Given the immense size of this special market, even a modest slowdown will have enormous consequence for American manufacturers.

It is difficult in this summary analysis to pinpoint the precise reasons for the decline in the relative competitive position of American manufacturing. As a general matter, relative to manufacturers in several other nations, most American goods producers simply are not making things that are good enough to lead the market in their sectors. American manufacturing has been losing position especially in making market-leading, high value-added goods. This results from a failure to modernize strategies and production systems to accommodate marketplace demands. More specifically, three observations can help to explain these issues in terms that can contribute to state government policy formulation.

First, many American manufacturing firms, especially the smaller ones, do not employ the level of technology to enable them to produce goods of the quality, reliability, or precision the markets demands.
Second, many firms appear to have difficulty in financing modernization strategies. Firms of all sizes tend pay a higher price for capital than do competitors in other nations, and smaller firms face additional problems of access to financing.

Third, and most important, most manufacturing firms report serious problems—an emerging crisis—in obtaining and organizing the skilled workers and managers needed for competitive production.

This paper will review these issues in more detail and suggest priorities for state government action and state governor leadership. It will outline best-practice thinking and present a few new ideas on the question of how state economic development systems should seek to modernize America's industrial base.

Two biases should be noted in advance. The first is a conviction that the question of how young people and adult workers can be better prepared for excellence at work is fundamental to America's future. The second bias is toward policies that promote collaboration among businesses. The vast majority of manufacturing firms are unconnected with each other and therefore unconnected with reciprocal learning systems that can help them to recognize and solve their common problems. Connecting them enables firms to learn from each other.

The Context of Global Economic Change

The competitive position of American manufacturing in the world economy has changed because so many firms—and the educational and financial institutions and government policies on which they depend—have failed to adjust satisfactorily to changes in the world economy. These changes have been enormous in scope, fundamental in consequence, and almost unbelievably rapid in speed. They have radically reshuffled the relative position of wealth and opportunity among nations, industries, and peoples. This restructuring of the global economy may be understood as the result of interrelated changes in markets, products, industrial technology and business structures.
Changes in Markets

Mass national markets have been replaced by segmented international markets. The revolution in information processing, transportation, and telecommunication technologies, propelled by divergent consumer tastes, has produced an increasingly niche-oriented marketplace. Rising affluence worldwide has contributed to highly articulated demand for consumer goods and, in turn, for the producer goods to make them. What used to be mass markets of undifferentiated demand have shattered into narrow fragments, each representing specialized demand for specialized product. Standardized products find little acceptance in this segmented-demand environment.

This market segmentation has been accompanied by an incredibly rapid market internationalization. Intense foreign competition now pressures businesses that have always seen themselves as on top of the international market or isolated from it. Manufacturers in America can elect not to export their products, but they cannot opt out of international competition. Goods produced in other countries now compete in virtually every corner of the American market. Many American firms are finding that if they have not honed their competitive edge in the export market, they cannot hold their own in the domestic market.

Businesses and governments in such Pacific Rim nations as Japan, Singapore, and Korea and in such European nations as Germany, Denmark, and Italy, have proactively sought to develop an export-based economy. Most manufacturing firms there of all sizes have learned what it takes to compete in international markets. In America, even the large firms have been slow to develop the ability to meet international standards of quality, delivery, reliability, and price. Small firms have lagged much further behind in learning to compete in a context of global standards.

Changes in Products

Standard products are giving way rapidly to customized products. Purchasers of standard, mass-produced goods that American manufacturers were very good at making were willing to accept products that
came close to meeting some of their needs. But niche demand requires highly differentiated products that precisely satisfy the very narrow application requirements of the buyer. Customized products, therefore, must embody higher levels of skill, knowledge, and technology than did standardized products. Customized products usually require application of sophisticated manufacturing equipment organized into sophisticated systems and operated by sophisticated personnel.

Niche markets are often volatile; therefore, customized products aimed at these markets tend to have very short life cycles. They tend to be either quite new items, tailormade for the buyer, or quite mature products, greatly specialized to particular applications. Such products do not compete principally on the basis of cost. They compete rather on the basis of quality, precision, and reliability of delivery as well as performance. Time is frequently more important than price to the buyer.

Cost continues to be an important, while not determinant, factor in competitiveness. However, cost control normally cannot be found in the scale of production. Instead, it must be found in design, in manufacturability, in the logistics of supply, delivery, and service, and in the quality and dependability of workers and managers.

Changes in Industrial Technology

The process of manufacturing is changing rapidly from the routine to the flexible. Hard automation technology of the past several decades involved capturing and building it into single-purpose machines and single-purpose systems. Flexibility was sacrificed for efficiency.

However, newer manufacturing technology has aimed at flexibility in production to accommodate a wider variety of customized products for the niche markets. The technology of microelectronic controls and reprogrammable automation is aimed at economies of scope, not scale. Multiple products, each tailored for different applications, can be produced almost as cheaply—or sometimes even more cheaply—in combination by the same machine or system of machines as separately by different machines or systems of machines. Computer-numerically-
controlled machines and computer-integrated manufacturing systems permit variety and flexibility of product without reducing efficiency.

This newer technology also reduces production time, improves quality, and slashes inventory. Computerized planning, inventory, and group technology systems can track multiple products through the factory while computer-based process control systems can assure uniformly high levels of quality. The industrial technology itself both undergirds and propels the changes to narrower market segments and customized products.

Changes in Business Structures

Rapid changes in markets, products, and processes are driving enormous changes in the structure of manufacturing establishments. Firms are shrinking in size, shedding overhead, and stripping away embedded layers of management hierarchy. Businesses must react quickly to rapid demand shifts in volatile niche markets. They must respond promptly to innovation in technology and to the demand for more specialized, higher quality, and shorter-lived products. The need for speed and accuracy in that response is driving a general decentralization of organization.

Larger manufacturing companies are devolving into smaller, more autonomous business units. Headquarters staffs are shrinking rapidly. Many firms who have had as many as 12 or even 15 layers of management between the chief executive and frontline supervisors are cutting back to six, or five, or even less. With good use of good information systems, managers who used to think they could properly supervise only a dozen employees at most are finding that they can effectively communicate with as many as 200.

A flatter structure within the manufacturing organization permits greater communication and cooperation among different divisions of the corporation. This in turn facilitates the increasingly sensitive, internal, and vertical communication needs crucial to processing the huge volume of information necessary to understand complex, volatile markets and technologies. These new structures require new ways of assigning tasks and new forms of organizing work. Managers and pro-
duction workers need a broader span within which to exercise group and individual authority. Organizational systems which emphasize horizontal communication place greater reliance on negotiation and collaborative decisionmaking.

In many industries, these trends are contributing to a disintegration of production systems. Many end product firms are “hollowing out”—out-sourcing an increasing percentage of the component requirements. This encourages specialization among their suppliers. As special opportunities or special problems emerge, they are addressed not by rebuilding large production groups, but by ad hoc task forces, special consultants, outside service vendors, and new, specialized suppliers.

The Special Issue of Small Manufacturing Companies

One of the consequences of this structural change is the relative growth of small manufacturers compared to larger ones. In virtually all manufacturing sectors, small establishments have increased their share of total establishments, total employment, and total value of production. Smaller organizations may often have a decided advantage over larger ones. They can be more agile, more immediately able to respond to market or technology shifts, and more nimble in spotting emerging market niches.

Smaller firms, however, can also lack the “sensing mechanisms” of larger companies. Their small scale normally precludes the maintenance of worldwide marketing and distribution systems that have enabled larger firms to spot market shifts rapidly. Meeting the needs of one narrow market niche may present special problems to the small firm in discerning the emergence of new niches.

Small firms also face difficulties in learning about technological change. They may not be able to support research departments and are less likely to participate in university-based research laboratories. They are less likely to hire new workers or technicians who could be expected to transfer new technologies, and they lack the flexibility of larger firms to send current workers to off-site training programs to develop familiarity with new technologies.
Around the world, small businesses are learning to solve these problems through collaboration. They have evolved new institutional arrangements for this collaboration—for performing on a joint basis those functions which they cannot perform efficiently on an individual basis. Similar patterns are beginning to emerge slowly in America. On the whole, however, American manufacturers are not well accustomed to cooperation. Especially among smaller firms, entrepreneurship tends to be an individualistic activity. Businesses have been fiercely competitive in local markets. The kind of manufacturing economy that dominated in America has not fostered inter-establishment cooperation. Cooperative links among small businesses, and between them and their larger customers, are developing more slowly in America than elsewhere in the industrialized world.

**Responding to These Changes**

American firms of all sizes have tended to respond more slowly to changes in the international economy than have competitor firms in other nations. The sheer size of the domestic market may have had the effect of insulating American manufacturers from the pressures facing more export-oriented firms in Europe and the Pacific Rim.

Moreover, the institutional framework within which American manufacturing operates—institutions of education, training, labor exchange, research, industrial relations, finance, and government regulation—has contributed to the slow recognition of the nature of these changes and slower still response to them. Even when industry leaders recognize the need to adopt newer technology or develop more highly skilled employees, this institutional framework, like an unwanted anchor, drags innovation and slows the pace of change.

Economic development is about helping American firms and these other institutions respond to changes in the world economy. It is about helping to equip them with the modern strategies to compete in the modern economy. That requires that we have a clear understanding of who we are seeking to help and how we will know if we have been successful. These points will be explored in more depth in the next section.
Summary

1. The world economy has been radically and rapidly transformed toward highly segmented, international market niches demanding customized, high value-added products which are produced through flexible, computer-based technologies.

2. Searching for agility and flexibility, businesses have downsized, flattened out, hollowed out and decentralized.

3. Small companies who employ best-practice technology and who learn to develop improved sensing mechanisms through collaboration can do very well in this new economy, but not many small manufacturers in America have done this.

The Technology Dimension of Modernization

Most state government economic development programs recognize the importance of technology to the development process. Most states are spending significant amounts of money under the general rubric of technology. However, most of the money goes to programs of applied research and technology development—usually university-based—that usually have very little to do with the modernization needs of most manufacturers.

A 1988 survey of state technology programs by the Minnesota Department of Trade and Economic Development (cited by the OTA (1990) in "Making Things Better") estimated that 44 of the 50 states have some kind of technology development program, and that they spend an average of $12.5 million per year. However, only about 2 percent of this seems to be going to programs of technology/managerial assistance while another 8 percent is allocated to technology transfer defined as "transmitting new technologies from the laboratory to the private sector." Almost 70 percent of the $550 million of state funding has gone to research grants or technology research centers.
In *Promoting Technological Excellence: The Role of State and Federal Extension Activities* (1989), the National Governors Association (NGA) concluded that most state government funds are going to programs of research and development. Yet, most program managers surveyed by the NGA project felt that the firms with which they worked required not new research and development, but better access to existing technology.

Most of the money spent by state government for technology development programs consists of grants to state universities for R&D activity. The grants often require consortial links with private industry. Yet, there is little evidence that such consortia have much direct effect on product innovation in these industries, even among the large manufacturers. In *The New Alliance: America's R&D Consortia*, Dan Dimancescu and James Botkin (1986) conclude that these state-supported programs have not yet yielded significant results of new product development.

One observer has termed this the "spaghetti effect." In *Stalemate in Technology*, Professor Gerhard Mensch (1979) of the University of Berlin writes:

> The spaghetti effect explains the lack of innovations as the result of inertia of captains of industry. If you move one end of a limp piece of spaghetti, the other end will not move. A large fund of knowledge is building up, but it is affecting actual practice at a very slow rate. It is a well-established finding of innovation research that "technology push" is an inferior way to introduce new technologies on the market; "demand pull" is a major factor for successful innovation. If this demand is lacking, the rate of innovation is low. (p. 155)

Dimancescu and Botkin conclude that "American enterprises must rethink the business of managing technology so that, when opportunities arise out of industry-university partnerships, they can tap the potential." They conclude that R&D consortia have not provided impressive results in offering a mechanism for such learning. The consortia tend to concentrate on creating new technologies; they spend relatively little effort in managing the transfer.
If major manufacturing companies are poorly equipped to manage the process of technology transfer from the R&D consortia, small companies face nearly hopeless odds. Sometimes, a "spin-out" can create new small, innovation-oriented manufacturing companies, but this happens very rarely. Most university-based R&D supported by state governments has little practical effect on the modernization needs of small American manufacturers.

This is not to argue that states ought not to invest in university-based consortia for technology research and development. But such investments probably have more to do with strengthening the research mission of the university and contributing to its instruction and community service missions than they do with technology transfer. This is frequently true with respect to the large companies who typically join these consortia. It is almost always true with respect to smaller companies who rarely can indulge in the luxury of university-based research consortia.

The problems of technological competitiveness in the small firm sector of America's industrial base are not problems of basic or applied research. Small firms rarely learn about technology from university-based R&D programs. Nor should they. They learn about technology from the market and from their relationships with other firms in that market. Modernization strategies should help to improve the way that these firms link to the market and to each other. Later sections of this report will offer suggestions on how to do this.

At a macro level, there does seem to be a problem with the extent to which large industry is investing in development of new technology. But, the problem of America's small manufacturers is their failure to apply current technology. Small American firms are not adopting the levels of "off-the-shelf" technology that are in widespread use among companies in other parts of the industrialized world and among the better-practice larger establishments in their sector right here at home.

Japan has a large network of technology demonstration and assistance centers to help small companies assess new technology. According to the OTA (1990) report, there were in 1985 about 185 testing and demonstration centers with 7000 employees and an annual budget of
about $470 million providing advice to small firms on issues of advanced technology and technology adaptation.

In *Old World, New Ideas: Business Ideas From Europe*, Joseph Cortwright (1990) offers a useful distinction between *technology transfer*—moving laboratory breakthroughs to their first commercial application—and *technology diffusion* (or deployment)—making sure all firms use techniques that are as close to best practice as possible. The American manufacturing sector as a whole may be underinvesting in research and development and may have a serious problem with technology transfer. But small firms, in particular, are suffering what may be a crisis in technology diffusion. Most state programs are either not aimed at this problem or not funded to provide much help.

Two recent studies of the patterns of technology use among small manufacturing companies have reached a similar conclusion: the vast majority of these companies do not employ the level of technology that larger firms have found necessary to compete in the world economy. (See Industrial Technology Institute 1987 and Kelley and Brooks 1988.)

The Industrial Technology Institute study examined the use of 13 computer-based technologies among a large sample of durable goods manufacturers in the Midwest. A Harvard study (Kelley and Brooks 1988) reviewed the use of programmable machine tools among a national sample of metalworking firms. The two studies reached strikingly similar conclusions about the technology gap of small manufacturers in America. There were dramatic differences in the rates of utilization of the technologies between the larger plants and their smaller counterparts.

The Harvard study found, for example, that 95 percent of branch plant establishments of over 500 employees have adopted programmable technology in several applications. But of the single establishment shops of under 50 employees, less than half had installed even one programmable machine. Of the 13 technologies analyzed in the ITI study, only one (computer-based production planning and inventory control) was in use by over half of the small firms in the sample. Fewer than 20 percent of the small shops of less than 50 workers had adopted any of the other technologies and six of the 13 were being used by fewer than
10 percent of these small companies. However, for the larger companies, adoption rates ranged from a low of 26 percent for material handling systems to a high of 86 percent for planning and inventory control systems. The Harvard and the ITI studies also both revealed considerable underutilization of technologies even by those relatively few small companies who had chosen to employ them.

These two large studies tend to confirm the results of other more discrete studies carried out on a state-to-state basis. In Indiana, a 1987 study of technology strategies among small manufacturing companies (Indiana State University 1987) revealed very low rates of adoption of computer-based machines and systems that were widely used by larger companies. In Pennsylvania, a survey of small firms in metalworking, electronics, and medical devices revealed low levels of deployment of advanced technology and little planning by the small firms to use them in the future (see Osborne 1989).

The Harvard study further confirmed that rates of technology adoption are lower in the United States than in Japan. According to the study, in 1987 roughly 30 percent of all production equipment in Japan was computer controlled. The study estimated that only 11 percent of machine tools in America are computer controlled. Most observers agree that small firms are more technically advanced in Germany and Japan and that the technology deployment gap between large and small firms there is not nearly as great as in America.

The OTA (1990) report reaches similar conclusions. The rate of diffusion of modern manufacturing technology—most notably numerically controlled and computer numerically controlled machines—has been much greater in Japan and Germany than in America. Smaller establishments account for most of this difference.

In a few cases, the lack of computer-based technologies in smaller firms is not too worrisome. Some of these systems may not be nearly as appropriate to low volume shops as they are to larger establishments who have much more inventory coming in and much more product going out. On balance, however, the information on technology utilization by small manufacturing companies is discouraging. Economic conditions are creating new opportunities for innovative and flexible
small companies to develop custom-made goods for international market niches. Larger companies are finding more reasons to downsize, decentralize, and out-source, but most small manufacturing companies in the United States are failing to adopt the technology needed to produce the variety and quality demanded by the market or by those who assemble for that market.

Why don't small companies adopt the technology needed to produce quality-based, customized goods for a segmented, international market? The reasons are fairly simple and quickly evident by walking through these small shops and talking to the owners and their employees. Some owner/managers still don't see the need to use these technologies; some don't know how to choose or manage the machines or systems; some can't get the financing for them; most don't have workers who can operate them.

Most of the problem of technology deployment among small goods producing firms is on the demand side. Generally, the supply of technology is at hand; it is known to the owner/manager; and while assistance on how to select and install appropriate technology may not be easy to use, it is not that hard to find. It is organized demand for the assistance that is lacking.

Most small companies in America are not well-linked with sources of information about technology deployment. They are not able to take advantage of the unstructured information and assistance available to them. They are too busy putting out today's fires to worry about tomorrow's. They don't know precisely where to get the help that is available. They are intimidated by "experts." They don't trust vendors. They don't think they can afford new equipment. They don't think their workers can operate these new systems and they don't know how to train them to learn. They think they can squeak by on what they have, doing things the same way they have always done them. They don't think they can manage the process of modernization. They are so focused on how things are that they lack the vision of how things could be. And most of all, they don't have the collaborative relationships that enable them to learn from the experiences of other companies.
The absence of strong horizontal linkages among small firms and of strong vertical linkages between small supplier firms and their larger customers helps to explain the low technology adoption rate. As noted above, in Japan there are extensive systems of government-provided and subsidized information and technical assistance programs. In fact, to get public financing under many of the extensive lending programs, management and technical analysis by one of these sources is usually required. Yet, even in Japan, most small businesses report that they get most of their information about technologies from other firms. This pattern of interfirm linkages and shared information systems is also highly developed in Germany, Italy, and other European nations. In America, by contrast, a cultural and institutional bias against collaboration has prevented the emergence of these learning systems.

Summary

1. Small firms lag behind the large, best-practice American firms in their sectors and far behind their counterparts in Japan and Europe in the rate of adoption of modern manufacturing technology.

2. Most technology program spending is not aimed at diffusing currently available technology.

3. Technology deployment strategies need to recognize the "cultural" aspects of the small firm environment that retard collaboration, discourage reciprocal learning, and slow the pace of technology adoption.

The Financial Dimension of Modernization

Relative to other industrialized nations, the capital required to finance modernization efforts is more expensive in the United States. Real interest rates are generally higher than in Japan or Europe. They are higher because our large budget deficit forces extensive govern-
ment borrowing and because the domestic savings rate is far below that of most other industrialized nations.

As a consequence, capital investment in the United States has tended to lag that of other industrialized nations. Both large and small manufacturers sometimes find the high cost of capital a disincentive to financing the advanced equipment associated with best-practice technology.

The high cost of capital is exacerbated by the often observed tendency of American manufacturers to focus on short-term gains to the neglect of longer-haul strategies where technology development and deployment policies might play a more prominent role. A high percentage of the capital of public American firms is owned by institutional investors whose managers tend to turn over their stock holdings frequently in order to optimize the current return on their investment. Businesses tend to seek to maximize their short-term profitability in order to maintain their attractiveness to these institutional investors on whom they depend for so much of their investment capital. Smaller, privately held companies generally mimic the behavior of the larger firms.

Further, there is some evidence that outmoded accounting practices in America discourage new capital investment in advanced manufacturing technology. Cost-accounting techniques that ignore the benefits of improved quality, reduced inventories, and quicker introduction of new or improved products may have the effect of undervaluing investment in new technology. When applied by company accountants or bank lending officers, these accounting principles can suggest less payback from new investment than is required by conventional lending standards to justify borrowing.

In contrast, a high percentage of the equity capital of manufacturing companies in Europe and Japan is held by private investors (such as other manufacturing companies) who are not so concerned with short-term profitability. Moreover, European and Japanese firms tend to raise a greater share of their investment needs in the form of debt from banks and insurance companies. Often these financial institutions hold a major share of the equities in the companies to which they lend.
In several nations of the Pacific Rim and Western European nations, government industrial policies strengthen the manufacturing sector and promote the deployment of advanced technology. These have the effect of reducing the risk of lending as seen by the financial institutions. This cushioning of risk for the lender reduces the cost of lending to the borrower.

Federal government-subsidized lending is dramatically higher in other industrial nations. In Japan, federal government direct loans to small and medium-sized business (not just manufacturers) amounted to about $27 billion in 1987. Loan guarantees were even larger—about $56 billion. By contrast, federal direct loan assistance to small business in the United States in 1987 amounted to just $47 million, and loan guarantees totaled only about $3.6 billion (OTA 1990).

The Japanese government provides other forms of financial assistance to small manufacturers specifically to acquire modern technology. The Equipment Modernization Loan Program made 6,000 loans in 1987 for a total of $293 million, all to firms with fewer than 100 employees. It provides interest free, no collateral loans for up to one-half the cost of new manufacturing equipment. The Equipment Leasing System provides low-cost funds for very small companies (fewer than 20 employees) to lease equipment. In 1987 this program provided 4,500 loans amounting to about $350 million. (see OTA 1990.)

These are staggering numbers. With this kind of assistance available from the federal government, it is little wonder that the rate of technology diffusion among small manufacturers in Japan far exceeds that of the United States. While comprehensive research is not available on small business lending in Germany or other European nations, there is anecdotal evidence of substantial government lending to promote technology diffusion in the small manufacturing sector.

There is little likelihood of significant easing in the federal budget deficits which might contribute to lower interest rates in America. As long as the economy remains so greatly dependent on foreign capital, interest rates will probably remain high. These same problems make it highly unlikely that the federal government will instigate new financing programs aimed at accelerating the rate of technology diffusion. In
fact, there is growing likelihood that the current programs of the Small Business Administration (which have never been very popular with banks and borrowers) may be cut back in the years ahead. Moreover, the concern about laxity in government oversight of savings and loan company lending practices seems to be contributing to more stringent industrial lending policies by banks.

There is little that state governments can do to affect interest rates or the supply of savings available for capital investment in new machinery and equipment. Special fiscal inducements for capital investment and technology development are difficult and expensive policy choices for state governments. State policies can have limited effect on accounting practices. However, state governments seeking to help with financing problems of American manufacturers can find creative ways to increase the supply of capital and reduce its cost to companies seeking to raise money for modernization strategies. Many states have a long history of small business financing. Unfortunately, few states now target their financing strategies of manufacturing modernization. No reliable information is available on the extent to which state development finance programs are associated with manufacturing modernization programs. In most states, however, development finance programs are widely separated from the more technically focused modernization programs. The overall level of all business financing available from all the states does not approach the level of Japan or Germany.

Most states that see themselves as providing special financing for technology programs label this financing as "seed" or "venture" capital. The Minnesota study summarized in OTA (1990) identified 18 such state programs in 1988 spending a total of about $37 million. The NGA study, *Promoting Technological Excellence* (1989), identified $41 million of state funds and $59 million of "private" (presumably leveraged) funds going into seed capital activity associated with technology programs. It seems unlikely that very much of this money is going to help small manufacturing companies acquire manufacturing technology.
The financing challenges facing small modernizing companies go beyond the acquisition of technology itself. Technological upgrading is frequently accompanied by the need to retrain employees at the managerial and production levels. Modernization strategies often require firms to invest heavily in the development of new markets, to strengthen sales and marketing efforts, and to develop new systems for the distribution and service of products. These are expensive investments for small firms. They frequently cannot be satisfied by commercial banks. Often the credit requirements of small modernizing firms exceed conventional risk limitations of lending institutions. The borrowing needs can exceed the risk parameters of term, equity, and assets.

Yet, equity financing is not a realistic alternative for these small firms. Few small companies can satisfy or afford the regulatory constraints on public equity financing. Private equity is very expensive. Venture capital firms typically look for a return on their equity investment in the range of 30 to 40 percent. Most modernizing small companies cannot demonstrate the level of growth to support that kind of return. Even those who can are often unwilling to pay the price of giving up much of the ownership and control of their company.

There is an important gap in the capital market between the low-risk, low-return conventional lending of commercial banks and the high-risk, high-return investment of venture funds. Creative state policies and programs could narrow this gap. A few states have sought to develop new programs to meet this market need. Michigan has created a new category of private, nondeposit-based lending institutions known as Business and Industry Development Corporations (BID-COs). Indiana has provided for the establishment of a private and for-profit consortia of banks to pool their higher-risk lending and structure that debt in innovative ways. Ohio and Michigan have experimented with a public subsidy for the loan loss reserve fund of private banks who are willing to exceed their conventional credit limits for firms in this mid-risk range.
Summary

1. The cost of capital for modernizing a manufacturing company in America is higher than in the nations with which we most directly compete, and this is not likely to change.

2. Federal government subsidies for capital investment and lending in America fall well behind those of our competitor countries, and this is not likely to change.

3. State government development finance programs are not well targeted to the needs of small modernizing manufacturing companies, but new initiatives are beginning to emerge.

The Human Resources Dimension of Modernization

The United States confronts a deepening crisis in the supply of skilled workers. Employers in virtually every business sector report increasing difficulty in bringing the skills of current workers up to the levels required by the sophistication of the modern workplace. They are even more discouraged by problems in recruiting young, new workers with these higher level skills. Nowhere is this crisis more apparent or more serious than in the manufacturing sector.

In *Made in America: Regaining the Productive Edge*, the MIT Commission on Industrial Productivity (1989) concluded two years of extensive research on issues of competitiveness in the U.S. economy with the following observations:

Without major changes in the way schools and firms train workers over the course of a lifetime, no amount of macroeconomic fine-tuning or technological innovation will be able to produce significantly improved economic performance and a rising standard of living. . . .

The issue is not mainly what workers will do when motivated but rather what they can do, given weaker basic education and the kind of work experiences provided by companies that have low regard for training and few institutional resources to provide it.
Problems of worker preparation result from a number of economic, technological, and demographic shifts which have not been supported by compensating improvements in education, training, and employment policies.

**Jobs Require More Skills and Different Skills**

Workplace changes have profoundly increased the numbers and altered the variety of skills required of workers and managers. Complex machines and systems demand greater technical proficiency as well as the flexibility to react quickly and accurately to changes in market and production. The way that tasks are assigned, the way that work is organized, and the way that technological improvements are introduced all require workers with more skills and higher level skills.

The application of modern technology to the manufacturing workplace has not resulted in the "de-skilling" predicted by some several years ago. Instead, the effective utilization of modern technology demands workers with the technical abilities to operate sophisticated machinery and systems. Skills required of new workers have increased enormously even in America's most basic industries. The president of one of the nation's largest steel companies put it recently: "Virtually every major [steel] mill that survived the upheavals of the 1980s, did it by changing steel from a low-tech, strong-back industry to one that's on the cutting edge in applying everything from computerized process control to employee involvement."

That statement applies equally in virtually every sector of manufacturing. New employees in the steel industry and other basic manufacturing industries will require very high levels of technical skill. They will be expected to operate integrated processes and sophisticated equipment. They will work in autonomous teams of co-equals without foremen. They will need to make decisions quickly and solve problems independently of management hierarchy.

The American Society for Training and Development concludes from its research on job training and education issues that workplace skills in all occupations will require specialized job-related skills built on a base of the following seven "generic competencies":

1. Foundation skills—learning how to learn
2. Academic competencies—reading, writing, and computation
3. Communication—listening and speaking
4. Adaptability—creative thinking and problem-solving
5. Personal management—self-esteem, goal-setting, motivation, and personal career development
6. Group effectiveness—interpersonal skills, negotiation, and teamwork
7. Influence—organizational effectiveness and leadership

American Students and Workers Have Not Been Well Prepared for These Changes

Most of our students and workers have been poorly prepared for the economic and job changes of the past several years. A number of recent studies have pointed to lagging educational achievement levels and lagging worker skill levels in the United States relative to other industrialized nations.

Education reforms in the 1980s focused on improvements in teaching elementary concepts through more standardized testing, aggressive accountability, stricter teacher certification, increased pay, curricula reforms, and longer school days and years. Some improvements in basic math and reading skills are discernible in some. Yet, national assessments of student and graduate achievement show that students are not using their knowledge effectively in thinking and reasoning.

The National Assessment of Educational Progress (NAEP) found that practically all young adults who finish high school are able to use printed information to accomplish routine and uncomplicated tasks. For many, however, these skills are so rudimentary that comprehension and ability to utilize the information is minimal. The NAEP found that only 11 percent of high school students can properly read a bus schedule. Only 10 percent can compute the cost of a meal from a menu or find specialized information in a news article. Only about 5 percent can
understand specialized information likely to be found in a professional or technical working environment.

These educational deficiencies relative to work requirements have existed for several years and now permeate the adult workforce. As far back as 1982, a survey of basic skills in the workforce conducted by the Center for Public Resources found that 50 percent of companies surveyed reported managers and supervisors unable to write paragraphs free of grammatical errors; 50 percent reported skilled and semiskilled employees unable to use decimals and fractions; and 63 percent reported that deficiencies in basic skills limited the job advancement of employees who were high school graduates.

**America Lacks Systems of School-to-Work Transition**

Among the industrialized nations of the world, the United States may be the only country with no organized program of school-to-work transition. When noncollege-bound youth graduate from high school, if they do, most simply drift for four or five years or more through a succession of generally low-paying jobs with little career opportunity and practically no skill development. This period of floundering helps to explain the high rate of self-destructive behavior among young Americans relative to their counterparts in other industrialized nations.

Most schools do little to counsel the noncollege-bound young person in how to prepare for the world of work. Students are not introduced to concepts of employment and employability as a part of their schooling. Nor are there nonschool institutions that help young people to learn systematically about different career opportunities and about the kind of preparation necessary for those career options.

Noncollege-bound youth, in particular, have seen little incentive to do well in high school, little incentive to work hard to master basic skills. They get few messages that strong basic skills and hard work have much to do with their life after high school. While research does indicate that educated workers are more productive (and that includes those who achieve higher grades in high school), a wage advantage does not materialize until several years after leaving high school.
Those gains are not apparent to young people while there are still in school.

Vocational education programs are achieving only limited success in helping to improve the job readiness of noncollege-bound youth. The MIT (1989) study, *Made in America*, argues that high school vocational education in the United States has had a “disappointing performance” and is not viewed by employers as a source of skilled or even trainable workers. As a result of the limited effectiveness of vocational education and the absence of a viable apprenticeship program outside the construction industry, the study concludes that: “there is no systematic path to training for the non-college bound. This lack of a structured transition from secondary schools to work results in weaker skills than those of European and Japanese workers. In this area American workers and firms are at a serious competitive disadvantage.”

The Supply of New Workers Will Drop Sharply

The number of new workers entering the U.S. labor force—barring dramatic changes in immigration policy—will drop significantly over the next 15 years from the unusually high levels of the past three decades when baby boomers and women entered the labor force in record numbers.

Many current attitudes and behaviors regarding education, work, and training were influenced by this unusually large influx of workers, lasting as it did for nearly 30 years. Personnel policies and training priorities were shaped for a generation of workers, managers, and businesses by this surplus labor market. Young workers came in at the bottom rungs of the employment ladder and not much was expected of them in terms of educational attainment or skill proficiencies. Seniority, not performance or skill, was the chief criterion for advancement to better paying jobs.

While demographics have changed, the mind set of many employers has not. The coming dearth of young workers could substantially constrain the ability of companies to grow rapidly or respond quickly to sudden new market opportunities. Yet, most employers still report that they tend to fill new jobs at all levels, except within the managerial
class, by hiring new employees from the outside rather than by retraining and filling from within. With the labor market changes in store over the next few years, this will be a very risky strategy.

The manufacturing sector, in particular, is having a tough time recruiting new job entrants who might have the educational proficiencies required for technically demanding jobs. The school age population and their parents have heard so frequently of the demise of American manufacturing that they have begun to believe it. The poor reputation of manufacturing as a career has led to sharp reductions in industrial vocational education enrollments, particularly in metalworking occupations. With the overall supply of new workers dropping so sharply, manufacturing companies will find that their image—providing relatively few, low-skilled and “dirty” jobs for those unable to do well in white-collar occupations—will seriously impair their ability to attract workers out of the top-skilled 50 percent of new job entrants.

Demographic Changes Will Reshape the Composition of the Workforce

While the reduced supply of new workers will retard rapid change in overall skill levels, demographic changes will profoundly alter the composition of the workforce. Over the next 20 years, the workforce will undergo continual change in three key attributes: race, gender, and age.

Native-born white males, who now constitute 47 percent of all workers will constitute only 15 percent of the net new additions to the labor force during the balance of this century. The “feminization” of the workplace will continue; women will fill 67 percent of the net new job openings between now and the end of the century.

The sharp reduction in the proportion of the workforce comprised of young workers and the continued movement of the huge generation of baby boomers through the population have resulted in an aging workforce in all sectors of the economy. However, in the manufacturing sector, these demographic trends coincided with a dramatic slowdown in new hires as a result of the restructuring of most industries in the 1970s and 1980s. Moreover, the general notion that manufacturing is no place
for a young worker to get ahead has dampened the recruitment of job entrants. These factors have left many manufacturing firms—particularly the older basic industries—in a precarious position: the average age of workers in the Pennsylvania machine tool industry is 57. The average age of Indiana's 35,000 steel workers is 55.

These older workers, who represent a reservoir of skills, will soon leave the workforce in huge numbers. Many of them are highly skilled workers who, while they may have lower educational attainment than their younger co-workers, came into their trades at a time when craft skills were carefully developed and perhaps more highly valued. Their departure will strip many companies of their best workers. The next generation of skilled workers in some important industries is thin to nonexistent.

American Employers Lack a Tradition of Strong Employee Training

When jobs were simple and skill requirements modest, most American employers did not have to invest very much time or money in training their factory workers (except in the skilled craft trades with a tradition of apprenticeship). Most technology improvements were labor saving. Machines were relatively easy to operate. Most workers had the limited educational proficiencies demanded by the workplace. As work became more complex, few manufacturing firms were prepared to invest significantly in employee training. In late 1988, the Joint Economic Committee of the Congress issued a report, "Competitiveness and the Quality of the American Work Force," citing evidence that American firms, on average, spend a little over 1 percent of payroll for continuing education and training of their employees. Japanese companies spend between 2.5 percent and 3 percent, while European firms spend about 2 percent of payroll on keeping their employees' skills up to date.

Recent studies by the American Society for Training and Development (ASTD) have established that annual investments in formal, employer-sponsored or employer-provided training are about $30 billion annually. That represents about one-tenth the annual investment in
plants and equipment. The ASTD estimates that the majority of that training investment (and another $100 billion in informal training expenditures) probably occurs in fewer than 200 large firms.

Companies tend to train their most highly educated workers and thereby accentuate differences in educational levels among their employees. For example, recent ASTD research reveals that 79 percent of college-educated workers have received training from their employers. Of those who have completed high school, about 71 percent have received at least some training. But only 49 percent of non-high school completers have received any training from their employer.

Small firms tend to spend less on training than their larger counterparts. Since the educational level of employees in small firms lags that of workers in large establishments, and since small firm share of total employment and production is increasing rapidly in the United States, this suggests some special problems of skill development in the economy.

The relatively low level of employee training is particularly dangerous because of the growing concentration of sophisticated technological, managerial, and organizational information within private companies. One observer has referred to this phenomenon as the "privatization of knowledge." Frequently, such knowledge is viewed as part of the private capital of the company. While it is rarely proprietary in the sense that it is not also available to other private companies, it is increasingly not public. Educational institutions and public programs of skill formation have limited access to new technologies and therefore to the skills they demand.

Skill Formation and Technological Improvement Are Blocked by Organizational Culture

Improving the technical skills of workers to operate new computer-based technology without changing workplace organization is likely to be counterproductive for many manufacturing companies. Many technologies fail because outmoded corporate cultures ignore the human dimensions of their operations. Sophisticated technologies require skilled workers. These workers will need to be more intimately
involved in company management than their lower-skilled predecessors. It does not make sense to ask for workers with high skills but treat them as components on the assembly line. A worker asked to develop skills of teamwork and problem-solving is going to expect to be treated as an equal member of the problem-solving team. If workers are to learn from each other, they need to be provided with flat organizations and horizontal systems of communication.

A 1989 study, *Made in America II: The People Dimension* by Coopers and Lybrand, found that 96 percent of 400 manufacturing executives surveyed agreed that they should adopt participatory management principles; 65 percent believed that participatory management is the key to successfully implementing advanced technology. Yet, 55 percent of those executives said their own companies had not done enough about it. Most continue to cling to top-down management styles that are not compatible with the requirements or the capabilities of advanced manufacturing technologies. As the study put it: “Overall, manufacturers must realize that long term productivity improvement starts with cultural change enabling true participatory management. The sooner they start to make these changes, the sooner they will begin to reap the full benefits of the advanced manufacturing technologies.”

Summary

1. The effective application of modern technology requires workers with higher skills.
2. American education is not producing job entrants with these skills.
3. There is little connection between school and work.
4. The supply of new workers is dropping sharply.
5. Most current workers are not being adequately retrained.
6. Many companies are not well enough organized to utilize more highly skilled employees.
Some Guiding Principles in Pursuit of Policy

This section outlines some suggested principles which might guide the design of a comprehensive modernization strategy. These principles seek to gather the diagnoses of problems and opportunities of the preceding sections into a general framework that can help to establish the direction and to order the priorities for state action.

Make Industrial Modernization Strategies a Central Feature of State Economic Development Programs

Most states have some programs of technology development as key elements of their economic development systems. However, only a few states are addressing comprehensively the issues that surround the competitiveness of America’s industrial base. Even in states that appear to focus their development strategies around the needs of existing firms and new enterprise development, issues of manufacturing modernization are often obscured by R&D programs oriented to new technology development.

Some states appear to have written off their existing manufacturing base as “sunset” industry in favor of developing new technology and new businesses to commercialize it. This is not a reasonable strategy. The view that traditional manufacturing will somehow wither away to be replaced by a new set of growth industries suggests a flawed understanding of the economic changes now under way in the world. The issue is not somehow to capture growth industries; rather, it is to help existing firms develop the ability to make and sell products for which there is a strong market.

Given the diversity of America’s manufacturing base, it would not be realistic or even useful to suggest here which particular sectors within manufacturing should receive special attention from state modernization programs. It is important for each state to analyze its own industrial base with a view toward understanding the relative contribution of different sectors to employment and production and toward understanding the linkages among the various sectors.
This analysis need not be bogged down by ideological concerns about picking winners and losers. The notion that certain industries are irreversibly in decline—and therefore merit no attention from development agencies—while others ascend—and therefore are somehow deserving—cannot be supported from the microeconomic perspective of individual states. In virtually every industrial sector in almost every state, there are best-practice American firms competing successfully at the high end of the international market.

The issue is not picking winners or avoiding losers; it is understanding the problems of technology, finance, training, marketing, and organization that affect different industry groups differently and developing programs that can help. Some of these industry groups will be more important than others in terms of their overall contribution to state employment and income. Some states will wish to reflect this relative importance in allocating resources. Some states will not narrowly target specific sectors. All states should seek to analyze the issues of modernization in terms of how they affect different manufacturing groups.

Target Small Manufacturing Firms

Most advocates of modernization strategies argue persuasively for targeting state government policy toward small industrial base firms. There are about 340,000 manufacturing establishments in the United States who employ more than five and fewer than 500 workers. Most of these are quite small. About 95 percent employ fewer than 250 people and 75 percent employ fewer than 50. Two-thirds have fewer than 20 workers.

Manufacturing establishments of fewer than 500 employees employ over 60 percent of the workers in America’s manufacturing sector. As noted earlier, they represent a steadily growing share of total manufacturing establishments, production, and employment. They now account for well over half the value-added in American industry.

Larger firms tend to have the resources to address their problems of modernization. They are unlikely to be dependent on state government for advice and assistance on issues of technology, market positioning, finance, or human resource development. Any help that they may
receive from state economic development programs is likely to be much further out on the margin and therefore significantly less important to them than it would be to smaller firms. Moreover, it is often hard for any state to secure a reasonable share of the assistance benefits it provides to a large corporation with establishment located all over the world. There is simply too much opportunity for the fruits of these benefits to leak out of the state to other facilities elsewhere.

Yet, these larger establishments are themselves increasingly dependent on the strength of the smaller foundation firms. The larger final-assembly companies look to the smaller firms for dependable and quality-based components, for reliable delivery, and for reasonable costs. To the extent that smaller firms can capitalize on their potential for agility, flexibility, and innovation, the larger firms profit right along with them.

Smaller manufacturing firms tend to lag their larger counterparts in utilizing appropriate technology, training and organizing (and paying) their workers, developing global marketing strategies, gaining access to capital on reasonable terms, and learning from the experiences of other firms. If American manufacturing is to regain a more competitive position in the world economy, it is the performance of the smaller firms that must improve. It is in the smaller firms that the gap between best practice and common practice is most evident.

All of this supports the conclusion that small manufacturing firms employing fewer than 500 workers (or perhaps even fewer than 250) should be primary targets of state programs of manufacturing modernization.

Define Objectives for Modernization at the Level of Industrial Sectors, Not Individual Firms

Policymakers engaged in setting manufacturing modernization standards must improve their ability to establish clear performance objectives. Thinking clearly about objectives tends to encourage the setting of performance measures at the sector or regional cluster of establishments level rather than at the individual firm level.
What constitutes modernization in a small manufacturing establishment? How are we to know when it has been achieved? Current state government programs of technical, financial and training assistance—even the best of them—do not seem to have explicit goals in mind when they work with firms. "Jobs created" or "jobs retained" are not appropriate measures of progress in helping small manufacturers gain and maintain the ability to compete successfully in international markets. Most modernization strategies are unlikely to lead to the establishment of net new jobs. To claim to retain jobs as a result of some brief engagement with a firm is hardly credible. Yet, it does not seem adequate merely to count the contacts.

There are sharp limits to how much effect any state government program can reasonably claim to have on the behavior of any single firm. No state government has the resources to even touch more than a fraction of the small manufacturing firms within its borders. At best, state government programs may be able to provide directly some expert services to only a few hundred firms annually.

Measuring improvements in the competitive behavior of firms and in the behavior of allied systems or institutions is tricky business. It can be done only over significant time periods and only by looking at the aggregate behavior of a number of firms within a particular sector or geographic region where the modernization strategies have impact. Noting a rise or fall in the performance of any single firm touched by some part of a state program is hardly adequate for evaluating the benefits of modernization programs.

As states set goals for modernizing their manufacturing base they should seek to change the behavior of industrial sectors or clusters of firms rather than individual firms. States should also develop goals that address the behavior of those institutions or systems that small firms look to for information and help.

Organize Services for Groups of Firms, Not Individual Establishments

Just as goal setting should be at the level of the sector or cluster, so too should the actual provision of services. In "Making Things Better,"
the OTA (1990) suggests that it might be a reasonable goal for industrial extension programs to reach 24,000 firms—7 percent of the small American manufacturing companies—annually. It is unclear, however, what "reaching" these firms really means.

According to the OTA study, the Georgia Institute of Technology Industrial Extension Office, the oldest of the state industrial extension programs, typically spends two to five days per firm at an average cost of $4,000 each. The Michigan Modernization Service provides a much more intensive contact, averaging six consultant days per firm at an apparent cost of $20,000.

The OTA study suggests that one-on-one contact between technical specialists and company managers is the bedrock of industrial extension. That is, of course, the model of agricultural extension. It worked well in its time for agricultural modernization and it may be useful for some manufacturing firms some of the time. It is not at all clear, however, that the old agricultural extension model of one-on-one contact is wholly appropriate to the current economic context or to the issues facing the manufacturing sector. Rapid changes in markets and technology create such a fluid environment for the small manufacturer that single-event contacts with a visiting expert, costing $4,000 to $20,000 per contact, may be of sharply limited utility.

Modernization programs that have as their exclusive goal reaching individual firms on individual issues of technology application are probably not terribly efficient, and they may not be very effective. Becoming and staying competitive in the international economy is not a single-dimensional problem of engineering or equipment. Isolated and infrequent engagement with an engineering extension agent about machine problems does not somehow magically produce a competitive company.

None of this means that industrial extension programs have no place in state development strategies. On the contrary, such programs can be an integral part of a comprehensive strategy; they can provide a major share of the delivery system for a wide array of information and technical services. But one-on-one engagements focused around a single problem, firm-by-firm, do not appear to be very efficient or lasting
techniques. Single contacts by outside experts may be a part of a modernization strategy, but they are unlikely, by themselves, to trigger and maintain the process of modernization. The extension service model appears to be a little more effective if it can work with firms on a comprehensive basis to address interrelated problems of technology, finance, marketing, skill development, and organization. However, this kind of approach can still be very expensive if the unit of analysis and the target of service is the individual small firm.

**Work at the Scale of the Problem**

One of the common afflictions of state development programs is the tendency to work simultaneously at dozens of admirable goals with very limited resources. Too frequently, this well-intentioned effort to serve multiple constituencies means that no program even approaches the scale of the problem it seeks to resolve. At best, resources get so badly fragmented that programs which deserve serious attention get nothing but token support. At worst, policymakers convince themselves—and seek to convince others—that they are really doing something important. That can mean that real problems get covered up or swept away.

Industrial modernization efforts should be sized to the scale of the problems they seek to ameliorate. Industrial extension efforts that have a minimal amount of contact with a few hundred establishments in a state with several thousand small and medium-sized manufacturers will not do much good, and by not focusing on building systems of technology information exchange, finance, and worker training, they may end up being harmful.

**Understand Modernization as a Multidimensional Problem Requiring New Systems, Not Programs**

The small manufacturing firm seeking to modernize its operations doesn’t need more programs; it needs systems that work. Programs will rise and fall and come and go depending on the availability, year to year, of resources or the interest of a few people in key positions. Nei-
ther businesses nor state economic development programs suffer from a shortage of programs. Relying on industrial extension workers to provide sporadic contacts with a small fraction of the small firms needing advice and assistance on issues surrounding the effective use of modern technology may be a good program. It is not much of a system.

Technology diffusion and industrial modernization are not, at their core, engineering problems. Most small establishment owner/managers understand the appropriateness of computer-based equipment and other advanced manufacturing technology even if they themselves lack the technical background to install it. The fact that most of the technology appropriate to small and medium-sized firms has been around for several years and nonadopting small firms have regularly made decisions not to use it underscores the fact that the issue here is rarely technical. It is sometimes financial and most often human.

Modernization is not an event; it is a process, a way of being over time. It is not some static threshold; it is continual adjustment to changing conditions of market and technology. Modernization policies for a state mean creating systems of applied research, technology deployment, finance, education, and training that are responsive over time to the changing requirements of the firms. Modernization programs should reflect the multidimensional nature of the problem they seek to solve. That means that programs of information, technical assistance, finance, and training should be closely integrated. Loan programs, for example, should be tied to technical/managerial/market assessments and to the provision of skill training.

Helping small firms in a particular sector to form a consortium that will pursue, over time, their common needs for market information, worker training, and shared special-purpose technology is an example of creating a system. Helping to strengthen vertical linkages between major customer firms and their supplier network by investing in supplier certification training programs represents a systemic approach to problems of communication among firms in a production relationship. Creating systems of manufacturing modernization means working with lending institutions to create new arrangements for financing equipment purchases. These new arrangements either aim to reduce risk, and
therefore reduce the cost of loans, or to recognize risk, and therefore increase the return on lending. Direct state lending programs are not systemic.

Customized job-training programs typically are provided firm by firm to develop relatively narrow skills for particular operations associated with using new technology. This kind of training does not constitute a system of skill formation that will provide continuous support to modernizing manufacturing establishments. These firms will need multiskilled, flexible workers who combine a solid educational foundation with technical proficiency and learning-to-learn skills. When states spend money to help companies train workers, these are the kind of skills they should aim for.

**Involve the Users of Modernization Programs in Rationing Resources to Highest Priority Needs**

No state is likely to be able to allocate huge new amounts of money to the problems of the small manufacturers who need to modernize their operations. Given limited resources, it is crucial that states employ rationing principles to assure that the money spent goes to highest needs. One good way to ration resources is to insist that users pay for the assistance they receive. Many state modernization programs do not ask for even modest contributions from the user, sensing that the price might constitute an insurmountable problem for the small firms. This is probably not true. In fact, it is likely that the majority of small business owner/managers will see free services as not valuable services. While some subsidy may be appropriate, some fee seems equally so.

Over time, states should seek to turn full ownership of technical assistance efforts over to the firms who use them. States may continue to subsidize the technical assistance programs, but ownership by the firms themselves will involve them directly in making decisions about the services they most need. Even more important, the joint management of shared assistance programs will involve firm owner/managers in the consortial behavior that will enable them, over time, to start learning from each other.
Promote Collaboration Among Firms

A central thesis of this analysis suggests that small firms seeking to capitalize on current economic trends must develop learning systems that sense market and technology changes. Promoting group behavior among small manufacturers can create economies of scale for providing services. However, promoting collaboration among small firms is more important because it can create a collective intelligence, a way that one firm can learn from the experience of another.

In an economic era of volatile markets and rapid technological change, there is too much information available for any one small firm to grasp it adequately. If firms continue to behave as autonomous units, unconnected with each other, and if economic development systems continue to treat them as autonomous, unconnected units, it will be very difficult for them to acquire the intelligence to prosper in the global economy. State government programs can help by encouraging, even requiring, that firms in need of assistance group themselves together for those common purposes.

Redefine the Relationship Between Work and Education

Meeting the skill requirements of the changing workplace will require radical rethinking about the traditional division of responsibility between school and work. Conventional wisdom suggests that “if the schools would just properly educate young people, businesses will train them.” Regrettably, this conventional wisdom does not hold up to close inspection.

First, even when schools do educate young people properly, most businesses do not really train them—at least not very much or very well. Second, schools probably will not educate them properly. Given the realities of demographics and culture in America in the 1990s, and given the record of school improvement in the 1980s, it is unlikely that schools will be able to bring about any significant gains in the achievement level of their graduates. Third, work requirements will continue to evolve rapidly, forcing most adults to see themselves always as learners as well as workers.
Finally, it is not likely that the skills required to be a successful learner in the workplace can be formed in the schoolplace. Problem-solving, motivation, negotiation, and leadership are skills so intimately connected to the context of the learning environment that they probably can be developed only in the workplace. The nature of work is changing so dramatically that it fundamentally alters the historic division between school and work. State government modernization strategies should recognize and act on the need to reduce the boundaries between these institutions.

Summary

1. Modernization strategies should be a central feature of state development programs.
2. Modernization strategies should target small firms.
3. The objectives of industrial modernization strategies should be defined at the industrial sector level rather than the individual firm level.
4. Services should be organized around industrial sectors or clusters of firms.
5. State programs should be sized to the scale of the problem.
6. States should see modernization as a multidimensional problem requiring new systems, not just more programs.
7. The users of modernization programs must be involved in allocating resources.
8. Inter-firm collaboration is essential.
9. Work and education need to be integrated in new ways.
A Strategy for Manufacturing Modernization

The following recommendations incorporate the chief features of a state-level strategy for manufacturing modernization. These suggestions will not be uniformly applicable for all states and may be gratuitous for states that have sophisticated strategies. These ideas are not intended to be comprehensive; they are not a step-by-step blueprint. Rather, they seek to identify major points of attack to build on the principles of the previous section.

Planning and Organizing a Strategy

1. Analyze the industrial base. Designing a modernization strategy should begin with a careful audit of a state’s manufacturing base, conducted on a sector-by-sector or cluster approach.

A sector audit would identify firms in each sector and survey them to (a) establish the extent to which they now use technology appropriate to their markets; (b) determine the key issues that confront them, by region if appropriate; (c) measure the extent to which collaborative mechanisms for resolution of these issues now exist; (d) identify the arena of competition (i.e., do they compete mostly among themselves within the region, nationally with firms from other states, internationally with firms from other nations, or what mix of each?); and (e) determine the most important strategies that they should pursue to expand market opportunity and enhance their competitive position.

Only a few states—Michigan, Ohio, and California are examples—have attempted rigorous and comprehensive sector analysis for more than one or two key industries. A model for development of this analysis is the Manufacturing and Innovations Network (MAIN) initiative of the Commonwealth of Pennsylvania, Department of Labor and Industry. This project has selected four industries—plastics, apparel, foundry, and machine tooling—important to the economic base of the state. It is encouraging group approaches to the identification and resolution of common problems.
The MAIN project was inaugurated by the state through a Request for Proposals (RFP) which encouraged industry groups, trade associations and regional economic development organizations to carry out what the RFP termed a "strategic audit." The audit was to identify opportunities to retain and expand markets and to determine what the firms should be doing individually and collectively to capitalize on those opportunities. The RFP required that groups responding to the solicitation develop a plan of "shared services" around which the firms could cluster. Examples of those shared services were market information, technology, training, procurement, quality improvement, finance, and exporting.

This need not be an expensive process. The Pennsylvania project limited state support to $100,000 per industrial cluster selected to participate. The firms were required to put in some of their own money to demonstrate commitment.

2. Identify best-practice firms as models. If, as is argued in this report, firms learn best from the experience of other firms, it will be important to identify and hold up to inspection and emulation the best practices within the industry.

The MIT Commission (1989) study, *Made in America*, identified the following six key similarities among the best-practice firms studied.

- A focus on simultaneous improvements in cost, quality, and delivery
- Closer links to customers
- Closer relationships with suppliers
- Effective use of technology for strategic advantage
- Less hierarchical and less compartmentalized organizations for greater flexibility
- Human resources policies that promote continuous learning, teamwork, participation, and flexibility

These are the best practices that should be offered as models of behavior for small manufacturing companies. They can also serve to focus the technical and information assistance of state modernization programs.
3. Develop industry steering groups for sector-based strategies. Government-assisted modernization efforts will be more successful to the extent that industry leaders participate in their design and execution. That principle is well recognized in the exemplary systems of business modernization in Europe—particularly in Northern Italy and Germany—and in Japan. In some industry groups, it may be hard to establish leadership organizations. That may be an indication of which sectors are likely to be more concerned with and receptive to modernization initiatives.

The MAIN project in Pennsylvania offers an example. The state required that each project be industry-driven. The steering committee for each group is led by firm owners, managers, and union leaders.

Choosing the Target and Focus of Modernization

1. Target small manufacturers and their linkages with other firms. As has been previously argued, smaller companies are more likely to need and benefit from state government modernization strategies than big ones. Also, it is in the small firm sector that the gap between best practice and current practice is widest. Further, America's larger manufacturing companies are increasingly dependent on the quality of design, engineering, production, and delivery in smaller firms.

The stake that larger companies have in the fortunes of their smaller supplier base represents an important linkage that is often overlooked in state business assistance efforts. Many of the larger companies have developed major programs of technical assistance and training aimed at their smaller supplier base. State modernization efforts should consider these customer-supplier relationships as opportunities to help organize the demand for services they can provide. Similarly, linkages among small firms that might be geographically clustered in a particular area or grouped around a core of larger companies should be seen as opportunities to focus modernization efforts.

2. Concentrate technology programs on diffusion. It is argued here that the problems of technology facing small manufacturers throughout America have far more to do with technology diffusion
than with technology development or technology transfer. However, as we have seen, most state technology spending has been in applied research and development or in moving the results of this R&D effort to the commercial sector.

States need to refocus their efforts on the somewhat more prosaic, but certainly more rewarding, questions of how small establishments can be persuaded to use the level of currently available technology that their competitors in other nations are learning to use.

This does not argue for dismantling programs that several states have established to spur the formation of new manufacturing firms using new technology. Helping to seed the existing industry base with new firms who are drawing on the latest and highest technology available is a generally sound strategy. To the extent that it does not divert resources from higher and better use for technology diffusion, this approach out to be continued. It tends to be a very expensive strategy because states are rapidly drawn into financing programs such as providing grant funds to supplement the federal Small Business Innovation Research initiative or providing seed and venture capital to assist these new firms as they launch their new products. To the extent that this then inhibits the development of systems to aid current manufacturers, it may retard modernization strategies.

3. **Provide comprehensive and integrated modernization services.** As has been repeated above, industrial modernization is not just an engineering problem. In many cases, it is not even primarily an engineering problem. It is a set of issues that involve technology, finance, worker and manager skills, markets, and organizational culture. Not every firm needs information, advice, or help in each of these areas, but all of these factors will be important to some firms.

States need to find ways to help the modernizing process without segmenting problems into narrow categories to fit within the institutional boundaries between agencies or programs. One way to do this is to use the firm owners themselves as a funnel for services. If industry associations or groups of firms with similar problems or opportunities were to play a larger role in the design and delivery of modernization
service programs (see below), they might be able to serve as program synthesizers or integrators.

**Delivering Services**

1. **Provide support to industry associations.** States should consider some form of challenge grant program which would encourage the emergence of strong trade and industry associations for each of the key sectors identified in the audit. Chambers of Commerce or other broad-based membership organizations can provide value to their membership on general issues of public policy concern, but they will seldom be able to play an activist role in the modernization efforts of particular sectors.

   State modernization programs need strong private sector partners. It will not be possible for states to plan and carry out long-range strategies of technology development, training, and finance, targeted to the specific needs of key sectors, if public officials are required to rely on volunteers. Sporadic contact with task forces or committees or general purpose business organizations who typically are unfamiliar with the needs of special sectors will not be good enough.

   Creating staff expertise within the private association of firms in the most important manufacturing clusters is important to do even if full support from the members of that cluster is not immediately available. It will take time for the small manufacturers who are not well accustomed to consortial activity to see the benefit of such common effort. It will take time for the concern about competition within the group to give way to a concern about how the group can cooperate to enhance their individual ability to compete outside their region.

   The emergence of strong intermediary organizations supported by firms in the sector will come only gradually, and in some sectors perhaps not develop. But the willingness of firms within a sector to contribute to the development of such organizations may be a predictor of the extent to which that sector will gain and maintain a competitive position in the international market.

   Again, the Pennsylvania MAIN initiative offers experience and suggests a model which other states may wish to adapt. The Pennsylvania
Foundrymen's Association, one of the key groups involved in the MAIN project, historically has not play a major role in analyzing the market, technology, finance, and human resource issues confronting its member firms. It has focused primarily on nonshop-floor issues like insurance and environmental restrictions.

However, the Association's recent sponsorship of the strategic audit has begun to change the face of this more than 25-year-old organization. First, the Association has gained direct access to examining shop-floor problems, access that state agencies or university programs probably could never get. Further, it is emerging from the strategic audit process with a new and sophisticated awareness of the hard issues and real service needs of its members. Most important, the Association is developing a collective resolve among the members to pursue joint programs to meet these needs.

2. Deliver industrial extension services through the industry groups. Advice regarding technology deployment is more likely to be effective to the extent that it is seen as reflecting the judgment of other firms in the sector.

The creation and strengthening of intermediary organizations to act as "retailer" of technical information and hands-on assistance will help to assure that resources spent on firms in that grouping are aimed at what the firms see as the most important issues.

Delivering services through industry-managed intermediary groups should direct the assistance toward more fundamental issues facing the industry. Assistance delivered directly by state industrial extension agents on a firm-by-firm basis inevitably tends to be skewed toward the special needs of the firm requesting help, sometimes to the neglect of dealing with such fundamental issues as how that firm positions itself to deal with the market and with technology. When the role of the state is as a "wholesaler" of assistance, the intermediary organization is pushed to develop a consensus within the industry around these fundamental issues.

In the previously cited MAIN initiative in Pennsylvania, firms that became involved in four sector-focused programs (apparel, plastics, foundries, and machine tooling) seem to be able to drive quickly
through the more specialized problems to their common concerns such as training skilled workers, managing chemical and industrial wastes, finding new markets, developing new products, and deploying new technology.

**Building Development Finance Programs for Modernizing Firms**

1. **Provide financing for the costs of modernization.** Most state development finance programs are aimed at reducing the cost of capital for firms buying fixed assets. The costs of modernization sometimes are grouped around the acquisition of capital equipment such as computer-numerically-controlled (CNC) machinery, but frequently the fixed assets are only a small portion of the costs. Often there are substantial other costs of a working capital nature—training, developing new quality control systems, marketing, establishing distribution and service systems, etc. States need to reexamine development lending programs to consider their applicability to these capital requirements.

2. **Develop financing systems for the mid-risk capital gap.** As previously argued, many small manufacturing firms are limited by the scarcity of capital for mid-risk borrowing. Often, these firms are able to pay a higher cost for their borrowing than is required by the conventional low-risk, low-return loans of commercial banks. However, these heavily regulated, deposit-based lenders are seldom interested in expanding loan risk parameters even for the prospect of a higher return on their money. If the borrower's credit requirements do not fit within the narrow parameters of low-risk, low-return lending, the borrower is usually forced to do without the capital or look to equity markets for the money required for modernization efforts.

   A few states have begun to explore new strategies to encourage the establishment of pools of nondeposit funds for higher risk lending. The BIDCO initiative in Michigan is an example. The state has helped to seed these funds but they are mainly financed by private investor groups. While it is too early to fully evaluate the BIDCO initiative, it promises to meet some of the need in that mid-risk market where many manufacturing companies are looking.
A few other states have worked with commercial banking institutions to design new lending arrangements that can tap the money supply of these banks for higher risk projects. Indiana has helped some 50 banks jointly establish a private lending corporation. Each member bank has made a small equity investment in this corporation (sufficient to finance annual operating costs). Each has given the new institution a line of credit (now totaling over $12 million) that supplies the capital pool from which the organization draws its loan funds. Member banks help to identify prospective borrowers, usually established customers whose current credit requirements outstrip risk limitations of the individual bank.

The objective of the Indiana project is to have the member bank finance that portion of the borrower's need which fits within the bank's limitations. The joint institution draws on the pooled funds to meet the balance of the needs, subordinating its interest to that of the member bank acting as the primary lender. The higher risk portion of the project costs the borrower a significantly higher rate of interest (often involving warrants or other forms of equity-based "kickers"). However, the loan does not demand the return normally associated with venture capital, and it does not require the company to surrender ownership.

While the BIDCO initiative and the Indiana plan are not aimed exclusively at needs of modernizing small manufacturers, they offer the potential to supply the kind of capital these firms often require. States establishing such new programs should consider linking them directly with technology deployment programs as is commonly done in development lending programs in Europe and the Far East.

**Reforming Education, Training and Employment Services Systems**

1. **Develop new systems of school-to-work transition that focus on work-based learning.** Most business-education partnership activities are concerned with discovering ways in which business can support the school through assisting in school management, strengthening teacher preparation, providing mentoring and tutoring for students, providing exposure to the world of work for younger students, and
offering work experience opportunities for older high-schoolers. Though such efforts are desirable, they frequently do not go far enough in creating new relationships between schools and employers—relationships that will strengthen the skill formation of young people.

Some states are beginning to experiment with innovations that go well beyond conventional business-education partnerships into new forms of work-based learning. An example is the effort in Pennsylvania to develop a youth apprenticeship system that would offer a radically new approach to education and occupational skill development. In the emerging concept, youngsters 16 to 17 years of age who have completed their first two years of high school would compete for entry into a four-year youth apprenticeship program, organized on a cooperative basis among several school systems and a statewide industry group—metalworking—in the initial Pennsylvania demonstration.

The participants in the Pennsylvania experiment would progress through a tightly structured four-year curriculum of general education, technical education, and occupational skill formation. The curriculum would be developed to produce skill and knowledge outcomes agreed to in advance by industry and education specialists from secondary and postsecondary institutions. Most of the program (70 to 75 percent) would be delivered in the workplace by training firms hiring the young people as apprentices. More conventional classroom education would closely complement the hands-on learnings. The apprentices would be paid a wage for a 40-hour week regardless of the actual split in time between the school setting and the work setting. The objective would be to produce a multitalented, flexible, skilled worker in a high-wage, high-demand occupation who will also have, in addition to a high school diploma, as much as two years of postsecondary credit fully transferable to four-year institutions.

Indiana is considering a program similar to the one under way in Pennsylvania. Other states are moving to establish "tech prep" curricula that incorporate large amounts of work-based learning and to expand cooperative education programs, especially in the manufacturing sector. As in the Pennsylvania illustration, these new approaches
aim at getting a business directly involved in the content and form of education and skill formation.

The pace of technological change makes it virtually impossible for public schools to provide up-to-date equipment and machinery, especially for the more high-skill training programs required in parts of the manufacturing sector. To continue to look to the school place as the most appropriate environment for developing vocational and technical skills in new job entrants or in people seeking new careers is to limit unnecessarily both the quality of the instruction and the participation of the employer community.

Workplace-based vocational and technical training is the norm in most other industrialized nations. It increases relevancy, shores up employer confidence, uses more modern equipment, engages more attention and commitment from students, and provides a better setting for the socialization of new workers into the workplace.

2. Create incentives for employer investments in training. As noted earlier, most of the workforce of the early years of the twenty-first century is the workplace today. Virtually all of them, at least those in blue-collar occupations, are unconnected with formal systems of education and skill formation. If they are to receive training appropriate to the skill requirements of future jobs, most will have to get that training from their employers. Yet, most American employers are not accustomed to allocating significant budgets to employee training. To the extent that they have invested in training, it has tended to be in relatively narrow skills appropriate to the introduction of particular machines. Contemporary training needs are more expensive because they demand higher technical proficiency, and they require more time because they demand a broader set of skills.

States must find ways to help manufacturing businesses recognize and respond to the need to increase their investment in training. A few states have begun to look creatively at using their unemployment compensation funds to induce greater employer investments in skill development for current employees. Another approach would be to offer tax incentives for investments in training. For example, states could offer partial tax credits for training expenditures above a level of previous
years’ effort (following the approach employed by several states for R&D tax credits).

States also should consider increasing adult education spending and making funds available to companies for improving the basic educational proficiencies of their workers. States typically invest a tiny fraction (often less than 1 percent) of the money they spend for K-12 education in basic education for adults. Debate about the relationship between spending and quality seems to be a permanent feature of the school reform agenda, but little argument can be made against the proposition that increasing the basic proficiencies of poorly educated adults has a high payback. Yet, very little money is spent on this need, and that which is appropriated is commonly limited to local education agencies. It is not available to private companies even as an incentive to spur their investment in this area.

3. Create systems to certify work-based training. One of the reasons that employers do not adequately invest in training and employees do not take advantage of what is offered is the absence of a generally recognized system of certifiability and, therefore, transferability of work-based training.

On a global basis, the competitive company invests in upgrading the skills of its workers. Workers are seen as a company’s number one asset and are treated accordingly. However, in a local labor market, individual employers will be less likely to invest in training to the extent that they see themselves as one of the few companies making those investments. Employers are understandably reluctant to spend a lot of resources on upgrading the skills of their workers if they believe they might leave them for better jobs and will have to be replaced by workers whose previous employer has not invested in upgrading skills.

If individual companies increasingly come to see other companies as making similar investments, they are not as likely to hold back. Moreover, if most companies begin to make those investments in developing worker skills, companies who do not share in this behavior will cease, over time, to be attractive employers. In a tight labor market, workers may begin increasingly to discriminate among prospective employers based on the training benefits those employers provide.
Training benefits may begin to be viewed in a fashion similar to the fringe benefits of insurance and retirement. The states can encourage this behavior by helping to make very clear to all employers and workers just who is spending what money for training and employee development. Certifying work-based learning programs is a step in that direction.

4. **Focus training expenditures on developing skilled workers.** The biggest problem facing most modernizing small manufacturers is the shortage of skilled workers able to operate technologically demanding equipment and systems. Yet, most state training money goes to relatively narrow, task-specific training, which tends not to encourage skilled worker development.

If state programs were to refocus from training programs aimed at the single firm to industrywide programs, there would be more emphasis on developing broader, foundation skills among workers. This would require helping businesses with similar skill needs to form training consortia. It would also demand a closer or more long-term relationship between firms and local providers of training and technical education.

**Summary**

1. States should plan and organize a strategy that:
   - analyzes the industrial base;
   - identifies best-practice firms as models; and
   - develops industry steering groups for sector-based strategies.

2. States should choose the target and focus on modernization by:
   - targeting on small manufacturers and their linkages with other firms; and
   - concentrating on technology diffusion.

3. States should deliver technical services to industry, to include:
   - provision of support to industry associations; and
   - delivery of industrial extension services through industrial groups.

4. States should build development finance programs, to include:
   - provision of financing for the costs of modernization; and
• development of financing systems for the mid-risk capital gap.

5. States should reform education, training, and employment service systems by:
• developing new systems of school-to-work transition;
• creating incentives for employer investments in training;
• creating systems to certify work-based training; and
• focusing training expenditures on producing skilled workers.
References


