Innovative Infrastructure for Agile Manufacturers

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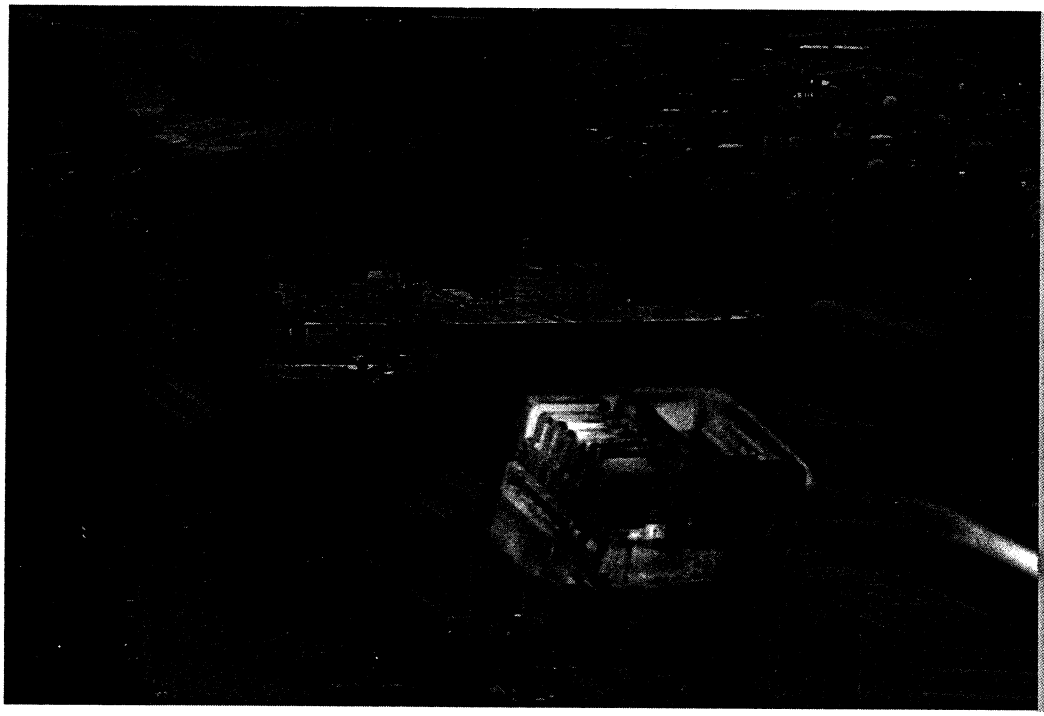

Increased global competition means that industry and government must work together to ensure that manufacturers have support networks of transportation, telecommunications, services, and knowledge centers.

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Speed-to-market, agile manufacturing, and the virtual corporation — terms firmly rooted in the lexicon of U.S. business — reflect an increasing awareness that competing successfully in the global economy will require extensive changes in the way U.S. corporations operate. In most industries, rapid worldwide political and economic shifts are increasing the number and power of new international competitors. Former socialist countries are entering the capitalist marketplace with vigor. What were previously Third World countries in Southeast Asia and Latin America are producing sophisticated goods and services. These new competitors are now smarter and more productive because their managers are better educated and have technical expertise and because the rapid cross-border diffusion of information and technology gives them nearly instant access to the latest know-how and equipment.

International customers are also more sophisticated and demanding. With access to an unparalleled variety of products from all over the world, they can more easily identify value. As a result, they have become more selective purchasers. They expect quality, reliability, and competitive pricing but also want customized products that are delivered quickly.[1] Much of their power lies in shifting product allegiances,

which typically focus on goods that provide greater immediate value.

Although these trends have already been explored extensively, most discussions of manufacturing agility and business process reengineering focus on how firms' internal characteristics must change.[2] Far less attention has focused on the external infrastructure that firms need to respond rapidly to changing global market conditions. To optimize agility and more effectively sustain virtual enterprises, manufacturers require a symbiotic business environment at the national, regional, and local levels to provide advanced infrastructure, logistical, and institutional support. Although many states, metropolitan areas, and cities in the United States are providing elements of that infrastructure, few are integrating or coordinating them.

In this article, we identify the components of the logistical support system that are needed to stimulate agile manufacturing, describe the reactive approaches of U.S. industry groups, cities, and government agencies, and examine the strategic integration of the components into a unified business support system, such as the Global TransPark (GTP) experiment in North Carolina.

Emergence of Agile Business

Agile manufacturing is "the ability of a company to thrive in a competitive environment of continuous and unanticipated change."[3] In nearly all industries, firms are adapting to growing international demands for flexibility and speed. Companies such as Motorola, Boeing, IBM, and Chrysler have reengineered their sourcing, production, and distribution systems to become more adaptable and responsive to customers. They compete on the basis of development cycle time, price, quality, flexibility, fast and reliable delivery, and after-sales support for their products. Ford manages complex global networks that encompass the value chain of suppliers, distributors, customers, and partners (sometimes including traditional competitors) within and across national borders.[4] Toyota's assembly plant in Georgetown, Kentucky, which produces 1,000 Camrys a day, is fed by a just-in-time inventory system delivering components from Japan and parts from the United States five times a week that are scheduled almost to the minute they will be used.[5] General Motors' Lordstown plant, which completed the shift to agile

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manufacturing in 1993, reduced its lead times by 38 percent, its inventories by 48 percent, and its production floor space by 27 percent. Goodyear Tire & Rubber slashed its management layers from 35 to 7 by adopting agile manufacturing and, in at least one plant, increased its capacity to make 215 different products.[6]

Agile manufacturers are also devising new systems that make them more responsive to customer needs. General Electric's "market-driven contract net" links sales agents directly to customers and to each other.[7] The agents control one or more manufacturing components — materials handling systems, machinery, manual operations, or inventory storage — and can bid on requests for orders, tailor order size, and alter design, production, and delivery times to satisfy customer needs. Ross Operating Valve Company established an agile plant in Lavonia, Georgia, where engineers work directly with customers via computer to produce customized designs for valves on demand. Using highly automated production systems, it can make as many as fifty different parts and transmit the designs in seconds via satellite to the firm's other plants in Michigan, Germany, Japan, and England with the capabilities to produce a wide variety of customized products.[8]

Even small and medium-sized enterprises increasingly rely on international networks of suppliers, distributors, and customers to improve their global competitiveness.[9] For example, small companies such as MICROS Systems in Maryland (which produces point-of-sales data collection equipment) and Reliable Power Products Company of Illinois (a manufacturer of insulators and hardware for overhead electrical lines) have increased their exports substantially by joining such networks. MICROS uses its international distributors to help modify equipment for local conditions and reduce its response time to changing customer needs. Reliable Power has increased its over-

seas sales by sharing trade leads and pursuing them cooperatively with other companies in its industry.

Companies of all sizes are developing strategic partnerships because so many different critical technologies are required to create today's sophisticated products that no one company can maintain leadership in all of them. To develop the Safari notebook, AT&T needed the assistance of Japan's Marubeni Trading Company to bring in the expertise of Matsushita Electric; MCI Communications uses up to 100 partners to bid successfully on contracts with large customers; and IBM, Apple Computer, and Motorola formed alliances for developing new computer microprocessors.[10] Traditional competitors IBM and Toshiba are jointly building a $1.2 billion manufacturing plant in Virginia to produce the next-generation 64-megabit memory chip. The two companies are working in a three-way alliance with Siemens AG of Germany to develop 256-megabit memory chips.

A variety of services beyond R&D and production — including financing, advertising, storage, and transport — are attached to these strategic alliances. At any R&D, production, or distribution stage, an affiliate can locate in any of a multitude of cities or countries, depending on local capabilities and incentives, market opportunities, infrastructure, and support networks.[11] The requirements of technological development and global competitiveness essentially make international suppliers, manufacturers, distributors, and customers interdependent parts of networked organizations.[12] Because agile manufacturing organizations focus on products and processes rather than on functions, they must have access to a wide range of external services in order to operate effectively.[13]

There are few institutionally sustained public partnerships with industry that offer customized infrastructure and external support services to improve competitiveness.

New Infrastructure Support Systems

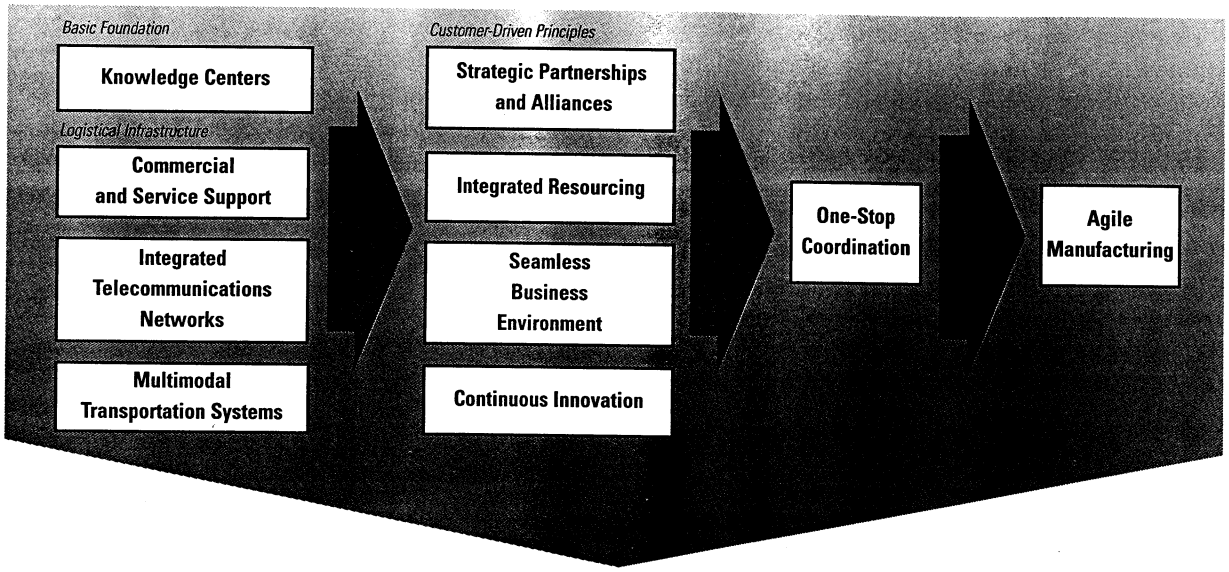
Much of the discussion of agile manufacturing, supply chain management, and virtual enterprises assumes either the existence of a support infrastructure for international competition or its spontaneous development. But there are few institutionally sustained public partnerships with industry that offer customized infrastructure and external support services to improve competitiveness.[14] The lack of such infrastructure, or weaknesses in integrating components, can undermine the benefits that agile manufacturers gain from in-plant changes and slow their response to global market signals.[15]

In the United States, two approaches are emerging to address the infrastructure support needs of agile manufacturing and global competition: (1) a reactive approach in which government agencies, industry groups, and cities build components of the infrastructure in response to perceived needs in their own industry or geographical area with little or no coordination or integration; and (2) a strategic approach in which projects that identify, develop, and integrate all the infrastructure elements attract agile manufacturers to sites where they can be supported effectively.

Reactive Approaches. In the United States, much of the support infrastructure for global competition is being developed piecemeal by industry groups and city and state governments to overcome bottlenecks. Often government and industry investments are completely uncoordinated. In contrast, corporations in Japan and the European Community often work closely with their governments in creating the infrastructure and support environment to enhance their competitiveness.[16] Japanese and European governments are investing in "smart" roads, high-speed trains, national information networks, and air-cargo systems to facilitate logistics, and in educational systems that are directly linked to industry's human resource needs. On the other hand, many older U.S. cities have lost valuable manufacturing capacity because of aging or inadequate infrastructure, weak education systems, poor workforce preparation, and adverse changes in their economic and social conditions (for example, high taxes, crime, and safety concerns).[17]

Strategic Approaches. A deeper understanding of agile manufacturing's characteristics reveals the inadequacies of the reactive, piecemeal approach to providing logistical support. Much of the competitive success of industries and the areas in which they locate will hinge on the ability of the public and private sectors to cooperate in creating a business environment that enhances manufacturing agility.[18] An example of a

Figure 1
Global TransPark Infrastructure for Agile Manufacturing



strategic approach that has anticipated the need for external support in future manufacturing is that of the public-private partnership in North Carolina that has designed and developed a prototype business infrastructure, Global TransPark (GTP).[19] The partnership will develop and manage 15,300 contiguous acres, located 70 miles east of the Research Triangle Park, as a synergistic industrial transportation center and link it to other countries to provide a supporting environment for firms competing in international markets.

The comprehensive GTP plan has fully integrated air, rail, highway, and sea transportation systems, and developed telecommunications protocols to serve agile manufacturers' logistical requirements *(see Figure 1)*. The GTP will also provide commercial and knowledge support services to improve value chain management.[20] Ultimately, the GTP's core will have a 5,000-acre, international air cargo, industrial complex centered by two long-range runways of more than 11,500 feet each. Just-in-time manufacturing and distribution facilities will be located directly along nearly ten miles of customized taxiways, enabling air cargo planes to nose-dock or side-dock with manufacturing and distribution facilities in the same way that freight trains move next to factories on railway spurs. A computer-guided electronic transfer vehicle network will move raw materials, components, and finished products to and from tenant facilities throughout the TransPark and to and from connecting intermodal transportation systems.[21]

State-of-the-art electronic data interchange (EDI) and intermodal technologies will facilitate seamless relationships among GTP tenants, their suppliers, and their markets by substantially accelerating materials handling, customs processing, and product transfers among industrial facilities, aircraft, trucks, and railcars, as well as to other airports and seaports. Full-scale commercial support, including foreign trade zone (FTZ) designation, and educational support (including distance learning capabilities) will give GTP tenants additional competitive advantage.

Business Environment for Agility

Four elements of the external infrastructure for agile manufacturers, when combined symbiotically with their internal operations, can create considerable competitive advantage *(see Figure 2)*.

Multimodal Transportation Systems

A minimized inventory and substantially reduced sourcing, production, and delivery cycles will drive the logistics of agile manufacturers in the future. Manufacturers must cut costly inventories by creating uninterrupted materials movement from source to manufacturer to market. As soon as an order is placed, manufacturers must acquire raw materials or

component parts regionally via surface transportation or by cargo planes from more distant sites. Manufacturers must quickly assemble finished products and deliver them by surface and air freight to domestic and international markets.

The adoption of agile manufacturing will depend on cross-docking facilities that permit products to flow rapidly and seamlessly through highways, railways, seaports, and airports. Companies' ability to adopt lean or just-in-time sourcing, flexible production, and speedy delivery to customers requires intermodal and materials handling systems (MHS) that bring diverse materials, parts, and components quickly to production sites and accelerate the shipment of assembled goods to regional and global markets.

The grocery industry estimated that it could save $30 billion or 10 percent of its logistics costs with a more efficient infrastructure.

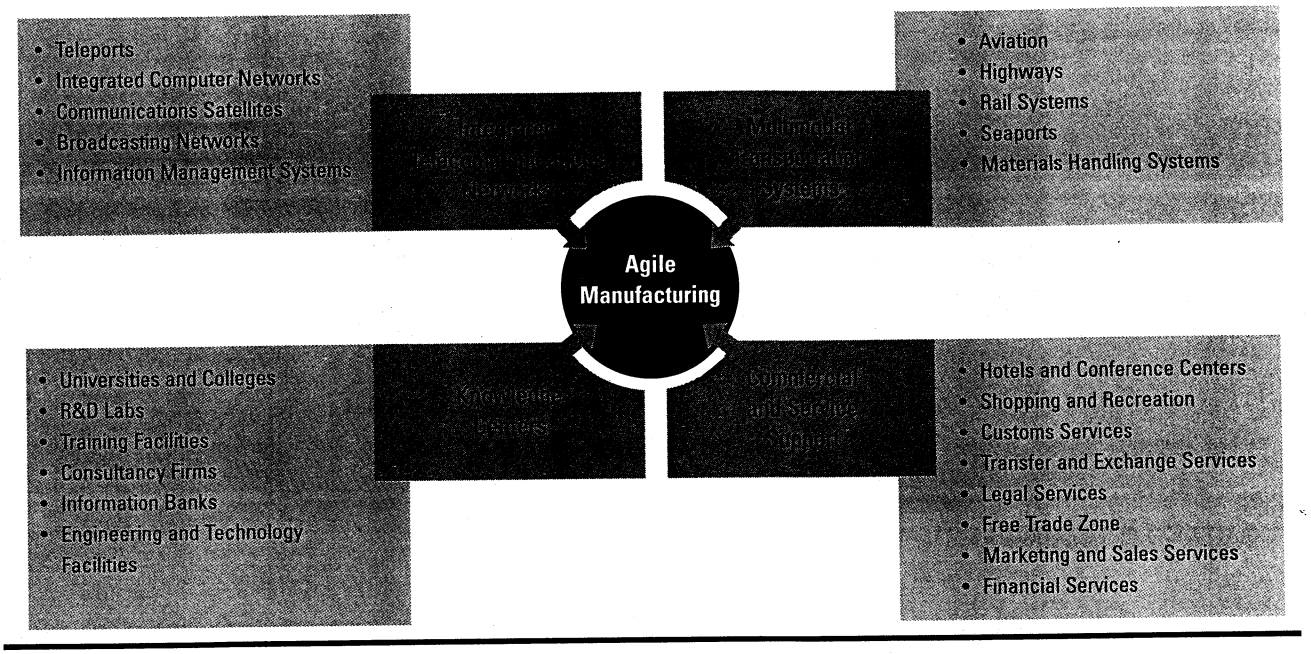
Agile manufacturers need advanced systems — runways equipped with new-generation navigational aids to assess the impact of weather and to reduce or eliminate delays and with radar to monitor low-level wind shear to provide high levels of safety and security. Ground transportation designs must incorporate redundant routes and intelligent highway systems to minimize the impact of congestion or accidents in connecting systems. Transportation systems must enable manufacturing input and finished products to flow in a timely, synchronized fashion. Large-scale air-cargo complexes, open twenty-four hours a day, seamlessly connected with efficient highways, modern seaports, rapid railways, and other aviation nodes can support clusters of agile manufacturing plants and more efficiently link them to their regional and global sourcing and distribution systems.

Transportation firms, cities, and metropolitan areas in the United States are developing elements of this multimodal transportation system, but nowhere has the entire system been integrated to support the new manufacturing. Firms operating cross-Atlantic ocean carriers, for example, are modifying their schedules, upgrading equipment, and operating more quickly to satisfy customers with just-in-time inventory and production systems.[22] Many airports are attempting to link with other transportation, although not always in a completely integrated fashion. The Huntsville, Alabama, International Airport, for example, has designed an FTZ specifically to accommodate just-in-time manufacturing. The Huntsville International Intermodal Center links air-cargo transport with railroads and highways outside the FTZ and offers high-speed delivery from storage facilities to manufacturers' plants with as little as thirty minutes notice.[23]

Some cities and states are reacting to increasing evidence that bottlenecks in surface transportation can wipe out gains from improved long-distance air-cargo transportation and reduce manufacturers' capacity to respond quickly to international customers. In 1993, U.S companies spent more than $670 billion (more than 10 percent of the gross domestic product) on logistics — packaging, loading, transporting, and unloading goods — in what many manufacturing associations consider to be an inefficient infrastructure system.[24] The grocery industry alone, for example, estimated that it could save $30 billion or 10 percent of its logistics costs with a more efficient infrastructure. In California, more than 300,000 work hours each day are lost due to highway traffic congestion alone.[25]

Several corporations are now developing elements of a more efficient surface transportation network — advanced traveler information, traffic management, vehicle control and safety systems, commercial vehicle operations, electronic toll payment, and emergency management systems — to reduce road traffic congestion and more efficiently link roads with air, rail, and seaport facilities. Atlanta's experiments with many of these intelligent transportation services during the 1996 Olympics provides information about how to adopt them for agile manufacturing. Image-processing devices — Autoscope Wide-Area Vehicle-Detection Systems — combined with overhead video cameras located accidents, congestion, and other traffic problems, alerted Atlanta's emergency vehicles and traffic control stations, and advised motorists of alternative routes. More than 300 of Atlanta's hotel rooms with interactive televisions received information from transportation management centers and interactive kiosks at Hartsfield International Airport. The Atlanta system demonstrated how cities can manage the interface between air and ground transportation more effectively. At the same time, Maryland and nearby states are exploring the adoption of intelligent

Figure 2
Four Elements That Support Agile Manufacturing



transportation systems to manage traffic congestion along the Interstate 95 corridor from Virginia to Maine.

Other cities are focusing on integrating sea and air transportation. Most international airlines are now adopting United Airlines' sea-air systems, and some cities have developed facilities to better integrate sea-air transportation. Seattle has the largest sea-air transit hub in the United States, accounting for about 23 percent of the world's sea-air shipments. Its system has reduced shipping time between Japan and Europe from thirty-five days to fourteen days.[26] Miami is developing facilities to link sea-air systems to transfer goods from the Pacific Rim and Europe to Central America, the Caribbean, and South America. And the Port of Anchorage is also developing a sea-air system for trade among North America, South America, the former Soviet Union, and northern Pacific Rim countries.

The North Carolina Global TransPark may be the only project in the United States, however, that will fully integrate a multimodal transportation system — road, rail, sea, and air access — for manufacturers and distributors in a single complex. GTP's infrastructure includes dual long-range airport runways that operate twenty-four hours a day and connect to two highway systems (Interstate 40 east and west and Interstate 95 north and south) and two major rail lines (CSX and Norfolk & Southern). Two deep-water ports linked to the GTP by rail and highways are each located about one hour away (Wilmington and Morehead City). Integrated air carriers will offer overnight or two-day delivery of components, parts, and finished goods around the world. A central cargo facility (CCF) zone is at the core of the GTP infrastructure with advanced materials handling that can accommodate the needs of a variety of industries. The CCF zone has an innovative, modularized facility to ensure flexibility. Materials handling systems will serve as intermodal integrators, providing seamless connections among different transport modes and to manufacturing and distribution facilities. The system will also allow manufacturing tenants to coordinate components from dispersed sites.

Integrated Telecommunications Networks

Agile manufacturers need integrated telecommunications networks to get information on markets and orders, adjust their product designs and product runs, track and manage material flows and inventory, pool R&D information, and upgrade management and employee skills. Agile manufacturers are increasingly exchanging computerized information among sites to do simulated product design, virtual prototyping, and concurrent or simultaneous engineering to reduce development costs and time.

Boeing, for instance, designed and prototyped (paperlessly, without mock-ups) its new 777 model in half the time and cost of traditional large aircraft design methods using three-dimensional computer simulation. Hundreds of geographically dispersed engineers interacted with each other and potential customers in real time through a globally connected IT network.[27] The textile industry is using point-of-sale terminals to give manufacturing instructions to computerized sewing and assembly workstations that speed production of special-order products to customers. In addition, clothing retailers are using point-of-sale scanners to replenish their inventories quickly to keep up with rapid changes in fashion and satisfy customer demand worldwide.[28]

Because the new manufacturing is so dependent on information systems, companies that adopt it must have access to electronic capabilities using fiber optics, high-speed digital switches, and satellite downlinks. In addition to advanced hardware systems, agile manufacturers depend on software tracking systems across transportation modes and compatible EDI that ensures reliable, efficient information flows among suppliers, manufacturers, and distributors while protecting proprietary data.

Several industry and government groups are developing components of a harmonized electronic infrastructure. The Microelectronics & Computer Technology Corporation, the National Center for Manufacturing Sciences, Sematech, and the Agile Manufacturing Enterprise Forum (which coordinates the collaboration of more than 200 U.S. companies and governmental and educational institutions pursuing agility) are jointly developing the Enterprise Integration Network. EINet enables electronic commerce to flow smoothly between hardware and software systems that use different protocols and languages.

In addition, agile manufacturers will be able to incorporate IT from the National Research & Education Network, an R&D network that allows scientists and industrial engineers to manipulate real-time data from widely dispersed locations. Concurrent Technologies Corporation (CTC) is creating asynchronous transfer mode, high-speed switching and data-transport technology for use with fiber-optic networks to transfer bulk product and process data between functional nodes.[29] This will create seamless interconnections of local and wide area networks that facilitate remote collaborative product design and shorten concept-to-product lead times.

The GTP is linking all these advanced telecommunications components into a comprehensive support system. The system will include an extension of the information superhighway, a network of multimedia communications devices including fiber optics as well as cellular and satellite links that connect companies to their customers and suppliers and to their own branches, offices, subsidiaries, and partners. Teleports with information and data processing capabilities will link to each other and to equipment on the customers' premises, including telephones, faxes, e-mail, EDI, and information management systems, and to video-conferencing equipment through fiber optics and worldwide broadcasting and communications satellite networks. Such infrastructure, outside the firm, complements and enhances the flexibility of its internal operations.

Commercial and Service Support

Agile manufacturing requires responsive commercial and service support. Firms with flexible business practices must have quick, efficient access to financial institutions; marketing, sales, and consultancy agencies; legal services; exposition centers; and FTZs. These services are particularly important to small and midsized firms that often lack the scale or resources to justify full-time internal support staff to meet these needs. The firms must develop links with private and public financing organizations to secure funding for their projects.

In reaction to these needs, agile manufacturers and high-tech companies that are competing in international markets but that still depend on proximity to older U.S. metropolitan areas are locating in "edge cities" — that is, in suburbs where they can create a newer infrastructure and a better quality of life and where they have access to large areas of inexpensive land.[30] Agile manufacturers and high-tech industries are seeking locations near research, service, and commercial support institutions, and will often leave older, inner cities to find them. Edge cities include the Route 128 area outside Boston, the Schaumburg district outside Chicago, the Perimeter Center north of Atlanta's Beltway, Irvine outside Los Angeles, and King of Prussia outside Philadelphia. These edge cities, which did not exist as urban areas in the 1950s, have substantial office space, large retail complexes, corporate headquarters, clean production facilities, and ample residential and recreational areas.

Indianapolis International Airport's FTZ links air transport with receiving, storage, quality control, and repackaging services.

Other areas seeking to accommodate agile manufacturers and high-tech firms provide some of the support needed for foreign trade and investment. Several airports in the United States are establishing commercial support systems. Indianapolis International Airport's FTZ links air transport with receiving, storage, quality control, and repackaging services.[31] The Huntsville, Alabama, International Airport facilitates customs processing, offers bonded warehousing, provides local control systems to speed zone-to-zone transfers within its FTZ, and links input suppliers with nearby manufacturers.

Other cities provide specific support for internationally competitive firms. Seattle's Office of International Affairs coordinates fourteen sister-city programs and gives government and business leaders information on international trade and cultural and political issues. It works with the Chamber of Commerce and dozens of other internationally oriented business and civic associations in maintaining international relations to attract new businesses. Tucson's International Trade Office in Asia helps attract Asian companies to its city and supports Tucson businesses that are exporting to Asia.

In addition, agile manufacturers' ability to attract professional managers and skilled employees requires an array of community amenities including good schools, shopping, and recreational and cultural facilities that make a local host area "world class," according to Rosabeth Moss Kanter.[32] Some U.S. cities are providing a quality of life that appeals to professionals, business leaders, and technically qualified workers. Studies of the preferred locations of high-tech firms in the southeastern region of the United States have found that livability and education are the most important factors in choosing location, followed by local transportation and available infrastructure.[33] The concentration of research-based industries in the Research Triangle Park in North Carolina and of research universities in the area, for example, has drawn many achievement-oriented people, giving the area the highest per capita concentration of PhDs in the United States. Likewise, the Minneapolis-St. Paul area supports high-tech and agile manufacturing companies by maintaining a clean, safe metropolitan area, providing outstanding schools, and cultivating the arts, music, and recreational resources.

Based on a partnership strategy between business and government, the GTP will tie together both onsite and offsite services to support its private-sector tenants. Once a manufacturer decides to locate in the GTP, management will provide a wide range of educational, technical, legal, and financial resources. The GTP will offer various specialized services for its tenants, such as coordination with government agencies, knowledge providers, and financial sources. The FTZ will make international operations more efficient and cost effective. Shared resources, such as harmonized EDI across transportation modes and onsite education and training facilities, will also help companies improve their value chain management while reducing fixed and operating costs.

As the partnership identifies the need for advanced workforce training, for example, the GTP Authority will be a conduit by establishing relationships between individual tenants and nearby universities and community colleges or to an onsite learning facility, if there is no training facility nearby. If a tenant requires financing, the authority will provide access to public and private financial institutions. In addition, the authority will help organize third-party logistics providers involved in moving input from suppliers' to tenants' plants and finished products to their customers. In this sense, GTP management will operate as "brokers," taking responsibility for dealing with customs and other government agencies, integrated carriers, freight forwarders, and other pertinent organizations in the supply chain, as needed or requested by tenants.

Knowledge Centers

Agile manufacturers want to be near or have electronic access to knowledge centers that can generate or stimulate innovation and provide a reliable source of scientists, engineers, and managers. Incorporating continuous innovation as a standard operating practice protects companies from the complacency that rendered previously successful firms obsolete by new technology. Among the most important knowledge centers on which agile manufacturers depend are R&D labs engaged in technology development, col-

leges and universities providing research capabilities and trained personnel, and consultants that help commercialize technology and manage international activities more effectively. Agile manufacturers also depend on business intelligence units and on workforce training and continuing education facilities that can help firms become and remain learning organizations.

A number of knowledge-based technology firms and agile manufacturers are locating in relatively newer cities in the southern and western parts of the United States. Houston, Dallas, Austin, Atlanta, Raleigh-Durham, Denver, Provo, San Jose, Portland, and Seattle have become centers for computer hardware and software industries, financial services, telecommunications, and medical technology and products firms by providing knowledge support systems.[34] Provo has the second largest concentration of computer software jobs, surpassed only by Silicon Valley. Orlando has developed the knowledge infrastructure, services, and incentives to become a center for electro-optics and laser technology.

Educational institutions in Austin can supply the skilled, educated workers that give it an advantage in attracting international companies.

Both domestic and foreign firms need disciplined, hard-working, and loyal workforces that only locations rich in knowledge centers can provide. Agile manufacturers depend not only on reasonable labor costs but also on a high-quality workforce. The skilled workers in Salt Lake City, Sacramento, and the Minneapolis-St. Paul area help companies increase their productivity and efficiency and adjust quickly to changing worldwide market demands. Educational institutions in Austin can supply the skilled, educated workers that give it an advantage in attracting international companies. Salt Lake City has the highest literacy rate in the United States, and, because so many of its residents have participated in Mormon missions overseas, they are better educated in foreign languages than people in most other U.S. cities. Phoenix attracts high-tech firms because of its large, well-educated, productive workforce and excellent school system, which includes a community college network geared to providing business skills.

North Carolina's GTP is developing a knowledge resource center that will support workforce training and development of cutting-edge technologies. It will offer agile manufacturers access to the extensive educational and technical resources located in North Carolina's Research Triangle Park, which brings together the state's universities and high-tech industries, government agencies, policy think tanks, and R&D labs. Distance learning capabilities that can be quickly adapted to tenants' needs will be a component of the knowledge resource center, as will links to sixteen community colleges located in the thirteen-county GTP.

Need for Strategic Approach

Some cities and states in the United States are creating elements of the infrastructure in order to attract agile, globally competitive high-tech manufacturers, but they provide only a few components in a fragmented, uncoordinated fashion, rather than in a well-planned, strategic approach. Although still in the formative stages, the Global TransPark in North Carolina and its sister networks in Asia, Europe, and Latin America are creating a prototype infrastructure that synthesizes all the components of the logistical support system to enhance manufacturing agility and supply chain management. Its one-stop coordination builds on strategic partnerships and alliances to create an environment that integrates resources and provides seamless transactions and continuous innovation through multimodal transportation, telecommunications, commercial and service support, and knowledge centers.

Economists, manufacturing consultants, strategic planners, industrial engineers, and others who understand current and anticipated global business requirements are designing the GTP. They recognize that some changes cannot be predicted; the master plan can be reconfigured. Thus the GTP is not a fixed physical plan but a flexible framework that can accommodate a wide variety of tenants, facilities, and physical layouts to modify easily with new technology and advances in infrastructure. Likewise, GTP management will maximize innovation, flexibility, and rapid response to evolving tenant needs and an ever-changing business environment. Hence, GTP management itself will function as an agile enterprise in generating or coordinating support from each logistical

or institutional sector. It will continuously seek new ways to add value for its tenants through services ranging from interactive distance learning and information transfer capabilities provided by the knowledge resources center to the latest materials handling technologies.

In an era of rapid, unanticipated change, the most competitive firms will be those that respond quickly and efficiently. Their success will depend not only on in-plant reengineering but also on external logistical and infrastructure support systems. Increasing the competitiveness of U.S. manufacturers in world markets will depend not only on accelerating the development of support systems but also on shifting from reactive to strategic approaches. The challenge for industry and government is to work together to integrate the infrastructure components into environments for manufacturing agility.

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