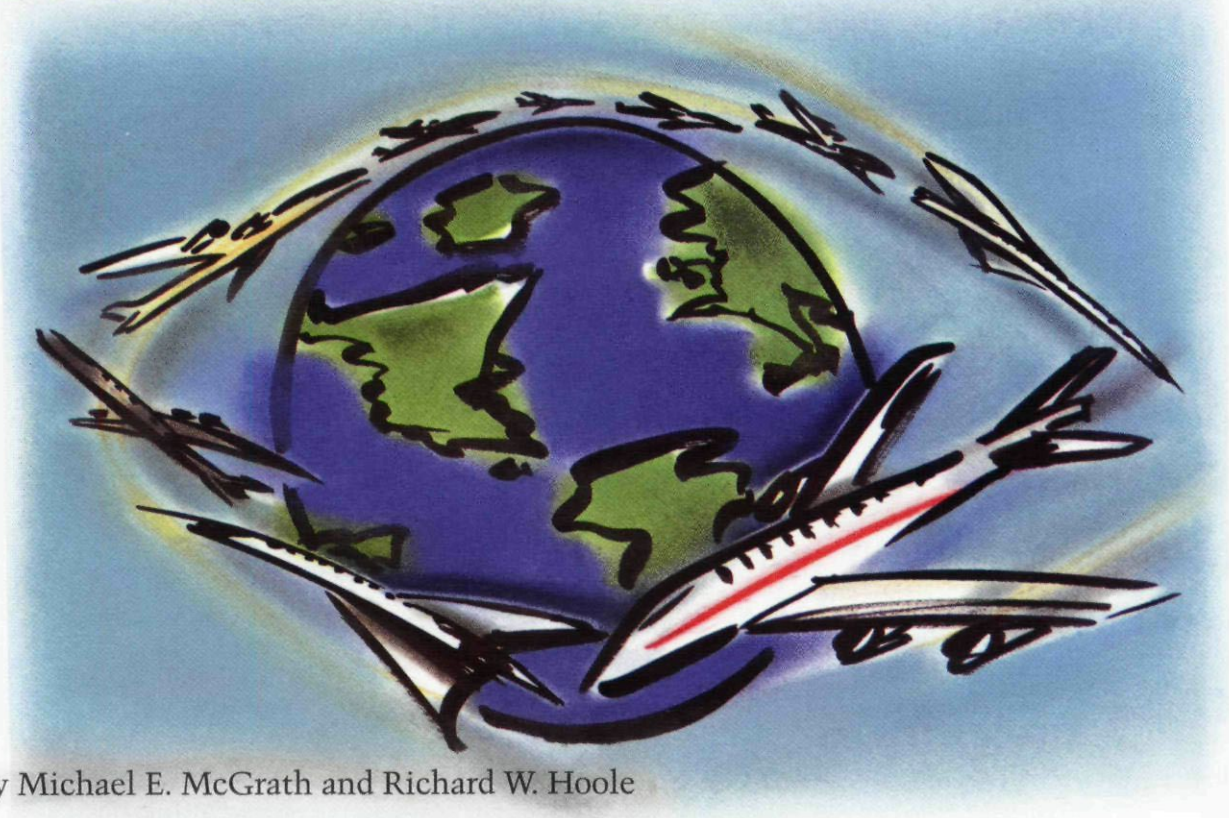
Manufacturing globally means rationalizing all the pieces of the production process.

Manufacturing's New Economies of Scale



by Michael E. McGrath and Richard W. Hoole

In the 1990s, manufacturing companies face the challenge of globally integrating their operations. Just as companies were forced to rationalize operations within individual plants in the 1980s, they must now do the same for their entire system of manufacturing facilities around the world. Multinationals that can no longer rely on sheer size and geographic reach can still integrate far-flung plants into tightly connected, distributed production systems – and seize the opportunity for a new manufacturing scale advantage.

For years, the diverse operations of many multinationals made good business sense. At one extreme, companies manufactured products close to their customers, tailoring regional operations at scattered plants to meet local needs. Other companies chose to centralize manufacturing, offering a selection of standard, lower priced products to all of the markets they served. Yet given the current competition, which includes smaller, more focused companies as well as other multinationals, leading manufacturers must step beyond what has succeeded in the past. As our work with Xerox Corporation, Digital Equipment Corporation, Coulter Electronics, and other companies indicates, moving toward global integration is a long, involved process that begins at the top, filters down through the organization, and includes innovations across all functions.

Of course, there are no easy solutions to the need for change on such a large scale. All multinationals must grapple with their own unique problems; each must come up with its own innovations. Still,

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while the focus varies from company to company, many manufacturers have tried similar approaches. Some have created international teams for different functions: international design teams or commodity management teams, for example. Others have emphasized doing a critical activity only once, such as designing a core product or entering a customer order.

Regardless of the ways in which companies initiate change, one fact remains the same: multinationals *must* integrate their operations if they expect to compete in the volatile global arena. They cannot go backward to complete centralization of manufacturing, or they will lose access to essential markets. Nor can they remain a disconnected system of geographically scattered operations. With a tightly coordinated network of plants in high-cost end markets and low-cost manufacturing centers, multinationals can achieve new economies of scale and cut costs by eliminating redundant processes. But in becoming globally integrated, these same companies must balance the tension between a monolithic central authority and the need to integrate independent units. And they must focus specific changes in functions and at individual sites by articulating a vision shared by the entire organization.

First Steps: Globalizing Xerox

No multinational manufacturer can claim complete global integration, perfectly implemented, with no hitches or complaints, or provide an exact blueprint for others. However, Xerox Corporation, with its complex web of international operations, embarked on a general strategy of global integration – and affirmed it publicly – at the right time.

At the end of the 1970s, Xerox was a typical multinational. The parent company, Xerox Corporation, designed and produced products in the United States for the U.S. market; Rank Xerox, a 51%-owned Xerox company, developed products for the European market; Fuji Xerox, an equal partnership between Rank Xerox and Fuji, created products for the Japanese market; and a number of other Xerox operating companies manufactured and sold a variety of peripherals and subassemblies throughout the world.

Each Xerox company controlled its own suppliers, assembly plants, and distribution channels. Plants in Mexico, the United States, Canada, Asia, Europe, and Brazil produced according to independently set schedules, based on forecasts from each individual operating company. The managers of these scattered plants gave little thought to how each one fit into the overall production plans of Xerox Corporation and rarely communicated with each other. And since Xerox had a near monopoly on the worldwide copier market, no one, including top management at parent headquarters, felt pressured to do so.

In 1981, senior managers at Xerox began to rethink the company's structure.

Nevertheless, in 1981, senior managers at Xerox began to rethink the company's structure, focusing on ways to cut costs, reduce excessive inventory, and speed up product delivery. Global integration was far from a well-defined strategy at the time, and managers did not pursue it with any urgency. But they accumulated information on the benefits of moving from a collection of independent regional units to a more integrated company.

Then, as the 1980s progressed, the competitive landscape started to shift. Xerox competitors such as Canon and Ricoh penetrated the U.S. and European markets with low-cost copiers. In 1983, Xerox dominated the top ten copier companies in the world with a 57% share of revenue; just two short years later, Xerox's share had fallen to 52%. More tellingly, in 1985, Canon announced it was globalizing production of its copiers. Until that time, Canon had manufactured primarily in Japan and sold through a worldwide distribution network; it was, in effect, a typical centralized, export-oriented company. But with new design and manufacturing facilities planned for the United States and Europe, Canon transformed itself into a decentralized multinational.

As competitive pressures bore down, Xerox picked up its own pace, pursuing an explicit strategy of global integration. The graph, "Xerox Achieves a New Manufacturing Scale Advantage," illustrates changes in operating income and revenue that reflect the company's growth. During the critical period between 1982 and 1991, Xerox made rapid innovations in many functions, which are highlighted in the time line that follows.

1982: Senior managers at Xerox realized the potential for cutting costs if the company consolidated raw material sources. They created a central pur-

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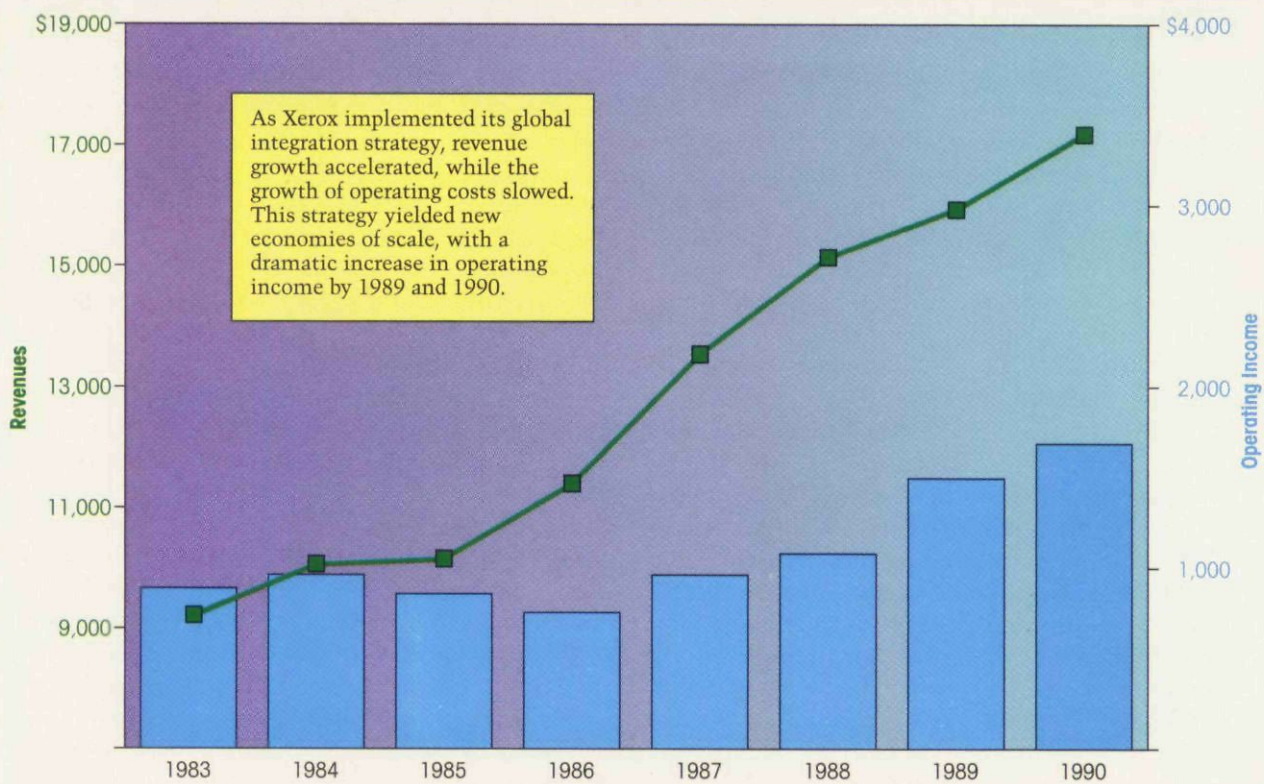
chasing group that included representatives from over a dozen of Xerox's multinational operating companies. This group of commodity managers identified and cultivated suppliers that could provide Xerox with high-quality, low-cost components on a worldwide basis. In the process, Xerox trimmed its global supply base from about 5,000 suppliers to just over 400, which now accounts for more than 90% of raw material purchases. For instance, Xerox now buys many of the lamps for its copiers from a single supplier with plants in Asia, Europe, and the United States. Because the consolidation of raw materials simplified purchasing, overhead rates have fallen from 9% of total costs for materials in 1982 to about 3% today. The result: Xerox now saves over $100 million annually on raw materials.

1983: Xerox Corporation introduced its Leadership Through Quality program to improve product quality, streamline and standardize manufacturing processes, cut costs, and increase return on assets. Senior managers recognized the power of such a program to improve communication of new management principles throughout its entire system of multinational operating companies and within the ranks of each company. Leadership Through Quality provided a common language of quality and a standard set of management practices that all of Xerox's companies now share.

1985 to 1986: Xerox instituted a new product-delivery process designed to standardize procedures. Functionally and geographically integrated teams took responsibility for introducing a new product in all major markets. Each product team managed the design, component sources, manufacturing, distribution, and follow-up customer service on a worldwide basis. One team designed a new product with universal power supplies and dual-language displays – for example, in both English and French – to eliminate the cost of reengineering for new markets at a later date. In general, using integrated teams has cut as much as one year from the overall product development cycle and saved millions of dollars.

1988: Xerox created a multinational task force to gather more specific and focused data on global integration. This task force identified three levels of integration and used them as a basis for restructuring various operations at all facilities. Xerox plants were required to (1) adopt global standards for basic pro-

Xerox Achieves a New Manufacturing Scale Advantage*



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cesses that apply to all operations (for example, databases for managing materials); (2) maintain common business processes but, where necessary, tailor them to local needs (for example, just-in-time programs); and (3) set site-specific processes for only those systems that must conform to local needs (for example, government reporting requirements).

Information from this task force allowed top managers at Xerox to compare product cost and inventory data at different plants so they could balance production levels and improve utilization of excess inventory. Over a two-year period, these activities saved Xerox $20 million. And when Xerox initiated a common just-in-time system, it also created a worldwide council that developed a set of metrics and goals for all plants to follow. At some plants, 90% of products are now delivered on a just-in-time basis, a quantum improvement, given that less than 50% were delivered in this way in 1988.

1989: Top managers at Xerox Corporation calculated that they could eliminate $1 billion in inventory and $200 million in inventory-related costs by linking customer orders more closely with production. They formed a multinational organization called Central Logistics and Asset Management (CLAM) and four multifunctional, product-focused teams to integrate the supply chain across geographic boundaries. The aim of CLAM is to base individual plant production levels on customer orders and to reduce excess inventory. One team developed a new process that took more than a month out of the production forecasting cycle. And Xerox has now reduced its worldwide inventories by $500 million.

> The global design process was fast – and saved Xerox $10 million.

1990: Xerox introduced its 5100 copier, the first product jointly designed for a worldwide market by Fuji Xerox and Xerox Corporation engineers. The 5100, manufactured in U.S. plants, was launched in Japan in November 1990 and in the United States the following February. Before that time, Xerox had never introduced a major product in two distinct markets so quickly.

In the past, the unique needs of the Japanese market, such as lighter weight paper, common use of blue pencils, and difficulties in copying *kanji* characters, meant separate product development programs for Western and Asian markets. That, in turn, meant products developed in this fashion required reengineering for other markets. However, Xerox assembled a team of Japanese and American engineers to design the 5100 copier from concept to finished drawings. The design team also received feedback from customer groups in the United States, Europe, and Japan. The 5100's global design process reduced overall time-to-market and saved the company more than $10 million in development costs.

1991: Xerox began integrating its product delivery activities. A CLAM team and several operating groups created a Western Hemisphere distribution center for spare parts, consolidating safety stocks previously held independently for the U.S., Canadian, and Latin American markets. Once again, such integration of operations saved Xerox several million dollars annually.

The Five Basics: Focusing Change

Xerox Corporation evolved its global-integration strategies over time and, to some extent, by trial and error. Realistically, changes at most multinationals do not happen neatly or in a fixed sequence. Similar small innovations may spark at the same time in several operating companies: automating certain parts of the manufacturing process, for example, or processing customer orders in a new way.

While there is no fixed starting point for globally integrating an organization, managers, both at the top and in individual operations, should begin with focused projects that address specific problems. It makes sense to focus first on a part of the organization where immediate and substantive improvement is possible. Xerox began its global-integration process in purchasing raw materials because management decided that was where it could make the most immediate and greatest gains.

The starting point might be in any of what we call the "five basics": product development, purchasing, production, demand management, or order fulfillment. The following sections provide suggestions for integrating each function and, while not definitive, show the range of possibilities.

Product Development. Designing products once and only once for the global market benefits companies in a number of important ways. Such a design process can eliminate costly, after-the-fact redesigns every time a company wants to enter a new market with a particular product. And combining this new process with international design teams can turn a multinational's scattered operations into a competitive advantage.

Each development project should revolve around the design of a core product, including the capacity

for design variations and derivatives tailored to meet the needs of local markets. In some cases, companies have included derivative designs in software or a "country kit" that contains items such as preprogrammed memory chips, labels, documentation, and special power cords. In other cases, extra elements must be included in the core product so it can

> Global contracts are so lucrative that suppliers can offer buyers better unit costs and schedules.

pass the regulatory requirements of specific countries. Often the cost of overdesigning a product to begin with is lower than that of redesigning the product later to meet idiosyncratic specifications in different countries. For example, one electronics company designs all of its products with additional shielding to prevent damage from liquid spills, even though only the United Kingdom and a few other European countries require such protection.

Creating international design teams is another crucial part of globalizing product development. If members of a product design team are located all over the world rather than clustered at a central site, each designer can monitor local tastes, technical standards, and changing government regulations. Designers in the field can also stay abreast of local technology developments and gain quicker access to competitors' products.

Of course, the global distribution of a design team introduces communication problems. But a good communications system, a necessary component of any world-class global enterprise, makes these problems manageable. For example, Digital Equipment Corporation, a pioneer in computer networking, created an electronic-mail network that links 100,000 employees worldwide. That means an engineer in Shrewsbury, Massachusetts can ask for help on a technical problem relating to disk-drive technology by typing a quick e-mail message. Within 24 hours, she may receive responses from fellow designers around the world that detail possible solutions. DEC estimates that the use of this application has contributed to a twofold reduction in product development time since 1988.

Purchasing. Economies of scale in purchasing come from consolidating raw material sources and paring down a company's supplier base. By purchasing on a global instead of a local basis, companies have the freedom to choose the best suppliers in the world, no matter where their operations are located. And because global contracts are often significantly larger than local ones, suppliers can offer buyers more favorable unit costs and delivery schedules. Some suppliers may even agree to set up local operations for a buyer if the contract is big enough.

To integrate purchasing, companies can create commodity management teams for all important materials. Commodity management teams select suppliers around the world and monitor their performance. Local plant-materials managers can execute the purchase orders and oversee daily supply flow. As for low-volume, low-cost commodities (particularly those with high transportation costs), individual plant staff can manage them based on local needs.

Each commodity management team is responsible for setting the cost, quality, and lead-time performance of the appropriate worldwide suppliers. Team members can be located anywhere in the world, although they must operate as a single group and make decisions for the company as a whole. Teams should include members from purchasing, engineering, finance, and quality assurance so that, as a group, they have the necessary expertise to identify world-class suppliers and ensure that the company gets the best performance for its money.

For example, Coulter Electronics, which produces medical electronics equipment, created commodity management teams that included representatives from all five of its plants. Early on, the semiconductor commodity team found that the company could consolidate half of all semiconductors it purchased into a few large contracts, saving more than $1 million a year. In another instance, the team discovered that the same three-way solenoid valve cost $20.87 in France, $17.50 in the United Kingdom, and $10.54 in the United States. By consolidating the purchasing of this valve, Coulter saved over $100,000 annually.

Production. To take advantage of their larger capacity and geographic diversity, multinational manufacturers must streamline the flow of inventory between plants. That means coordinating production of components in low-cost manufacturing centers with final assembly in high-cost locations close to customers. Mass producing component parts in Chinese or Malaysian plants, for example, can clearly cut production costs for a multinational. However, operating final assembly plants in places such as the United States or Germany is also essential for a number of reasons; for example, shipping the assembled product may be prohibitively expensive. In some instances, customers identify more closely with a company that has manufacturing facilities in

their own country. In addition, many governments levy lower duties if final assembly is done locally; or they may require local assembly to sell products in that market, as in Brazil.

Of course, many companies are unable to coordinate existing production facilities after years of rapid and often haphazard expansion. While new ventures, acquisitions, or mergers may lead to new markets, they may also leave a manufacturer with too much uncoordinated worldwide capacity in locations that make little strategic sense. And because the age and type of capital equipment varies from plant to plant, the quality and cost of each plant's global production also varies.

Managers can begin restructuring production by analyzing how materials flow from plant to plant. Coordinating and simplifying materials flow requires two things: (1) balancing production *vertically* within the production pipeline, from component manufacturing to final assembly; and (2) balancing production *horizontally* between plants that manufacture the same or similar products.

Balancing production vertically requires tightening the connection between scattered final assembly, subassembly, and component plants. We have found that creating a global system analogous to single-plant, just-in-time inventory management ensures the tightest connection. To do this, companies should first take their end-product forecasts and communicate general requirements to all plants at all levels in the production process. Each plant can use these forecasts for capacity and materials planning. Then, operating in parallel, real customer orders become the "pull signals" for the upstream plant in the system to produce necessary components. But while a pull signal in a single plant is often a physical signal (an empty kanban bin, for instance), in a global system with multiple production facilities the signal probably would be an electronic message sent over a computer network.

> When capital equipment varies from plant to plant, so will quality and cost.

Horizontal balancing, on the other hand, requires central coordination of plants that handle the same step in the manufacturing process, such as production of a particular component or final assembly. Because the same products are often manufactured by different plants in an organization, horizontal balancing involves assigning production based on cost, plant capacity, technical capabilities, availability of materials, and closeness to the customer.

For example, one company operates final assembly plants in two countries, each with dedicated metal-fabrication facilities that in the past manufactured many identical parts. One fabrication shop's outdated equipment produced complex turned parts very inefficiently. The other shop produced them quite efficiently, but because its skilled laborers received higher wages, its costs for manufacturing simple sheet-metal parts were far above the first shop's. By reallocating production – such as assigning more complex turned parts to the plant with highly paid, skilled workers – the company capitalized on the strengths of both shops and saved almost $1 million annually.

Demand Management. Managers use marketing and sales forecasts – the core of demand management – to set sales quotas, plan production schedules and inventory requirements, negotiate supplier contracts, and establish corporate revenue plans. If for no other reason than demand management, a sophisticated global forecasting system is necessary. Companies must gather information on the local level, integrate it into a central system, and then distribute the consolidated data back to all local operations.

However, before investing in a technical solution, management should first understand how the company uses current demand forecasts to set production. The biggest problem many multinationals face is that demand forecasting is a politically charged process. From central headquarters, which may be halfway around the world from the company's manufacturing facilities, senior managers set the annual forecast at the beginning of each fiscal year. This is then handed down to manufacturing operations to use for scheduling production. But because the forecast is also used by Wall Street analysts as a baseline for evaluating the company's performance, senior managers frown on any deviations from the plan. So if customer orders begin to fall, but production levels remain the same to meet corporate expectations, inventory accumulates and manufacturing managers are blamed. In fact, official adjustments to production forecasts often take months to make.

To address the problem, manufacturing managers should have the authority to adjust production levels to reflect actual orders. Over the last few years, Xerox has reengineered its global demand management process with this change in mind. Today teams of production planners and demand analysts at each operating company meet weekly to review production of each product family and adjust production and inventory levels. Each team uses an interactive

modeling system that graphically displays historical and projected customer demand, production output, and inventory levels, including relevant data from other related Xerox companies.

These demand management teams have the experience to make informed decisions on production changes and the authority to implement them, which has shaved weeks and even months off production planning times. In one case, a quick change in a plant's production schedule of copiers saved $100,000 in inventory and freight costs.

Order Fulfillment. To gain a new scale advantage in order fulfillment, companies must focus on coordinating customer orders with distribution at the global level. The result is more efficient order management, a decrease in total finished goods inventories, and quicker, more direct delivery. Companies should strive to cut all unnecessary warehousing and transportation of finished products on their way to customers. Ideally, orders are linked to the most appropriate factory, which then ships the product directly to the customer.

Companies can move toward this goal by first creating a globally networked order management system that keeps track of where different products are made, how they can be configured, where the customer is located, and how products are priced in different markets. In addition, the system assigns product automatically to a plant close to the customer. And by electronically transmitting, validating, pricing, and scheduling an order, the company can cut significant time out of the entire fulfillment cycle.

Take, for example, the complex order fulfillment problems of Digital Equipment Corporation, which must bundle a unique set of components – computer platforms, displays, printers, storage units, and communications equipment – that are manufactured by a variety of plants around the world and then ship a single, complete package to the customer. Just a few years ago, DEC's unwieldy fulfillment system involved endless negotiations between individual plants and distribution centers that added time and expense to each delivery.

> Manufacturing strategy should match business strategy; yet companies rarely connect the two.

Now DEC has simplified the process: the goal is to enter an order only once. Order processors use an expert system to configure each product, then coordinate production and shipment of each part to one of DEC's new consolidation centers. Even before the component parts arrive, employees at the consolidation center prepare the shipping documents and schedule a carrier for final delivery. The new process reduces the number of transactions, streamlines the distribution flow, considerably improves delivery time, and increases the accuracy of orders – and customer satisfaction.

Setting the Stage for Global Integration

Specific functional changes each contribute to a new scale advantage: flexible products, reduced costs, simplified manufacturing processes, realistic planning based on demand, or better customer service. But once a multinational acknowledges the need for global integration, the ultimate goal should be to make changes in all five basics.

Obviously, this is not a simple task. Rationalizing every scattered facility and operation as part of a coherent whole and establishing new systems may take years to accomplish, especially for a large multinational. While Xerox, DEC, and other innovative companies have integrated some systems, even they are still in the early stages. We recognize that change often happens by fits and starts and doesn't always spring from an overarching vision. Still, companies can use three general guidelines to set the stage for global integration and drive the first changes in the right direction.

1. Affirm a global manufacturing mission.

The manufacturing strategy must support the company's global business strategy and be consistent across all facilities. However tautological this statement sounds, it rarely holds. At some companies, regional operations often set their own manufacturing priorities, and corporate management has little power to coordinate their strategies. At other companies, there is no formal manufacturing strategy at all, only a series of manufacturing decisions made at different times and under different conditions in the company's history. In both cases, the end result is a poor match between manufacturing strategy and business strategy.

To align the two strategies, top management should analyze existing plants, including their location, capacity, the range of products they produce, and the ability and willingness of their managers to communicate with each other. Studying the manufacturing infrastructure in the context of a worldwide business strategy can point up glaring weaknesses and provide a foundation for a meaningful manufacturing mission.

But creating the manufacturing mission is only the first step. Senior management must *publicly* declare its commitment to global integration, outlining to employees, customers, and suppliers the vision it holds for the company. In this way, everyone understands the context for any and all changes that follow.

In 1990, Gaynor Kelley, chairman of Perkin-Elmer Corporation, issued a call to become "one company, global yet compact, coordinated, efficient." His company plan, which was distributed to all employees, is an outline for shifting Perkin-Elmer's focus away from optimizing each plant's manufacturing assets toward the coordination of all plants.

Similarly, in early 1991, NEC Corporation's president Tadahiro Sekimoto publicly announced plans for globally integrating the company. "Until a few years ago," he said, "we expanded through linear globalization, with control flowing from Tokyo to overseas units. Now we are pursuing *mesh globalism*, which means decentralized but still connected." Companies such as NEC have not only recognized the need for "mesh globalism" but also the fact that integration cannot happen without the knowledge and support of everyone involved.

2. Develop a profile of capabilities.

Senior managers must first understand the strengths and weaknesses of the existing manufacturing structure. They must have a realistic idea of what capabilities the company still needs and where to focus attention first before they can draft a specific plan of action.

Any inventory of requisite capabilities should begin with an effective communications and information processing system. Teleconferencing equipment, electronic mail, electronic data interchange, distributed computing, and multivendor connectivity are all essential to tie facilities together. In fact, since achieving a new scale advantage depends on quick and accurate communication between far-flung plants, top managers should make compatibility of computer and communications equipment a corporate priority.

Of course, well-connected facilities are useless if employees don't understand each other. Creating a common management "language" – a universal set of management practices and measurement systems – is also crucial. At Xerox, for example, the Leadership Through Quality program set the stage for the company's global networking efforts.

As a company evolves its information network and improves its global communication skills, it should also evaluate how to rationalize operations, but on a global rather than single-plant basis. For instance, by benchmarking its capabilities against the competition, a company can identify performance gaps. Managers then use this information to set aggressive goals for improving capabilities.

More important, benchmarking not only provides information on the product or plant level but also illuminates strengths and weaknesses at the corporate level. One international electronics company benchmarked its plants by function (purchasing, logistics, manufacturing) along a number of critical dimensions (customer satisfaction, product and process quality, cost) and uncovered several performance gaps. But in the process, management found that several plants had extremely efficient manufacturing processes. At the time, there was no mechanism for transferring such expertise to other plants. However, by identifying successes, the company could then focus on transforming the manufacturing process throughout the organization rather than just addressing specific performance gaps.

This company has now set up a database that includes information on all plants, organized by 250 separate performance measures. Top management actively encourages individual plant managers to use the database to compare their facility's performance with others in the organization and share knowledge of the most successful practices.

> Well-integrated facilities are useless without a common set of management practices and measurement systems.

3. Identify options, pick a plan of action, and target specific results.

The most immediate, nuts-and-bolts issues senior managers will address are redeployment of plants and equipment and the reengineering of critical processes. Managers must decide which plants to close immediately and which ones to target for expansion. They must determine which manufacturing processes require reengineering and which ones can continue as they are.

One large capital equipment manufacturer, for example, considered the entire range of choices for restructuring its five plants, from total centralization to total decentralization. It developed a model for all options, which included the impact of each location on local sales volume and the company's cost structure over time. The company also included the effects of varying 11 critical functions in each scenario it studied. For instance, management looked at what

product development process would work best in a system of four manufacturing plants as compared with a system of two, weighing the costs and the benefits of each scenario. While time consuming, this company's analysis produced a final plan that was widely supported across the organization.

> Manufacturers that successfully coordinate global resources will become stronger, more responsive companies.

Of course, once a company has selected a plan of action, it must also get quick, highly visible results. Even though change is a long-term process, management needs to demonstrate progress in the short-term. Otherwise, its larger mission may fail, given the competitive marketplace. Coulter Electronics started coordinating its worldwide purchasing by setting up a simple, PC-driven database. The system was up and running within a few months at minimal expense and paved the way for other fundamental organizational improvements in purchasing.

In fact, a company can target specific results in any of the five basic functions to establish early victories, set the stage, and build momentum for the ultimate goal: a fully integrated global manufacturing system. Taken one step further, a multinational's new scale advantage will come from increased interaction *across* functions. When companies globalize the design process, for example, they may also create products that are easier to manufacture. And when companies globalize purchasing, manufacturing is no longer tied to a specific plant, and designers are not limited by local suppliers.

A multinational of the future, fully integrated yet still flexible, may supply its component plants with raw materials from a single source; standardize the manufacturing process in its British, German, and American final assembly plants; enter customer orders into a worldwide order fulfillment system so that products are assembled in and distributed from the most convenient site; and install a sophisticated electronic network that links product designers, demand analysts, and production planners at all facilities. Companies like this will rationalize operations from a global perspective, even if it means making hard and initially costly decisions, such as laying off workers at one plant in Tennessee to expand another in Brazil.

Those multinational manufacturers that successfully coordinate and balance their global resources will evolve into stronger, more responsive companies, better able to cut costs and serve their customers around the world. And multinationals of all sizes that integrate their operations – and achieve a new manufacturing scale advantage – will control the competition today and in the future.

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