# Connected Manufacturing

**Thought-provoking essays from industry leaders**

Edited by Craig Hartman, Robbert Kuppens, and Dirk Schlesinger


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MANUFACTURING INDUSTRIES FACE unprecedented challenges. New competitors are emerging from countries such as China and India; incumbent companies are beginning to reap benefits from global supply chains; and customers are demanding customized products. To survive, manufacturers must reduce costs by standardizing processes and products globally, while responding flexibly to the needs of customers regionally.

The way forward is a shift to next-generation manufacturing. Only by using the latest technological developments can manufacturers establish processes and methodologies to support a competitive, global business.

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**Connected Manufacturing** contains viewpoints and advice from several of the manufacturing industry's most innovative executives. Editors Craig Hartman, Robbert Kuppens, and Dirk Schlesinger examine global manufacturing markets and share the experiences of pioneers who embrace the core principles of next-generation manufacturing to achieve sustainable, competitive advantages.




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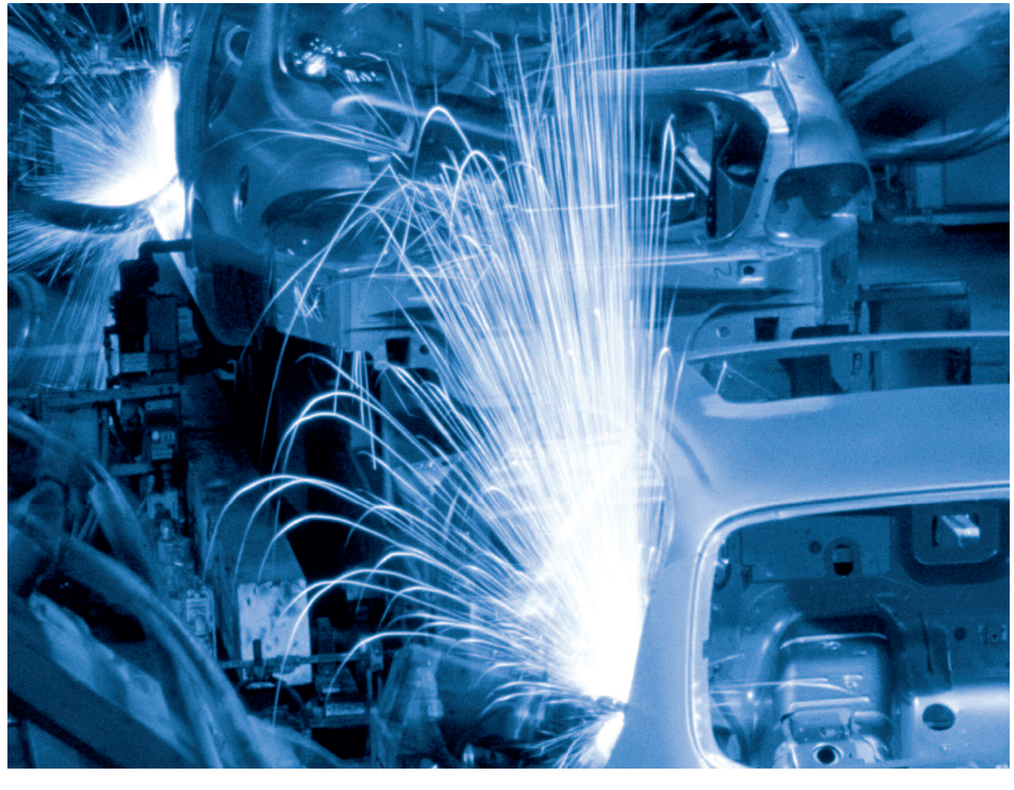

# Connected **Manufacturing**

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**The Cisco® Internet Business Solutions Group (IBSG)**, the global strategic consulting arm of Cisco, helps Global 500 companies and public organizations transform the way they do business—first by designing innovative business processes, and then by integrating advanced technologies into visionary roadmaps that improve customer experience and revenue growth.

The Cisco IBSG Global Manufacturing Practice provides trusted, independent advice to senior business executives from some of the world's largest manufacturing companies. IBSG helps customers improve their businesses through innovative programs and approaches targeting both new revenue generation and operational expenditure reduction. The Global Manufacturing Practice consists of a team of seasoned advisers drawn from the industry and the world's top management consulting firms.



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Edited by Craig Hartman, Robbert Kuppens, and Dr. Dirk Schlesinger

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SECTION 2: CONNECTED SUPPLY



# INTRODUCTION

Now is the time for companies to embrace the core principles of next-generation manufacturing and use them to achieve a sustainable, competitive advantage.

**Dr. Dirk Schlesinger**
SENIOR DIRECTOR, MANUFACTURING, INTERNET BUSINESS SOLUTIONS GROUP (IBSG), CISCO, GERMANY

# Next-generation manufacturing: a connected approach

**While global manufacturers have for years used technology to increase productivity and improve customer service, today they face unprecedented challenges. Tectonic shifts in the global economy have created important new competitors—and huge new markets in emerging countries. Plus, user demands for wider and more tailored products are forcing manufacturers to innovate faster and develop greater intimacy with end customers.**

At the same time, technology also has advanced. Manufacturers now have large-scale databases, integrated enterprise resource planning (ERP) software, radio frequency identification (RFID) devices, and broadband Internet—to name a few—to tackle these challenges. We find specific examples from around the world. GE Healthcare collects X-ray machine performance data online to reduce repair times and anticipate customer lifecycles. Boeing invests in Moscow engineering facilities to develop the 787 Dreamliner. Emerson Electric Co. designs and manufactures core product modules in China and then customizes them locally. Kia Motors America moves manufacturing from "low-cost" Korea to cheaper facilities in Slovakia. CEMEX S.A. de C.V., Mexico's leading cement manufacturer, integrates tracking and fleet management technologies to meet customer delivery requirements within 20 minutes.

These examples demonstrate a shift to next-generation manufacturing. They show, as we see in Figure 1, how manufacturers are emphasizing bidirectional information-sharing through the global manufacturing value chain—from research and development (R&D) to the customer and back; from suppliers to plants to sales-channel partners, and conversely.

**Next-generation manufacturing**

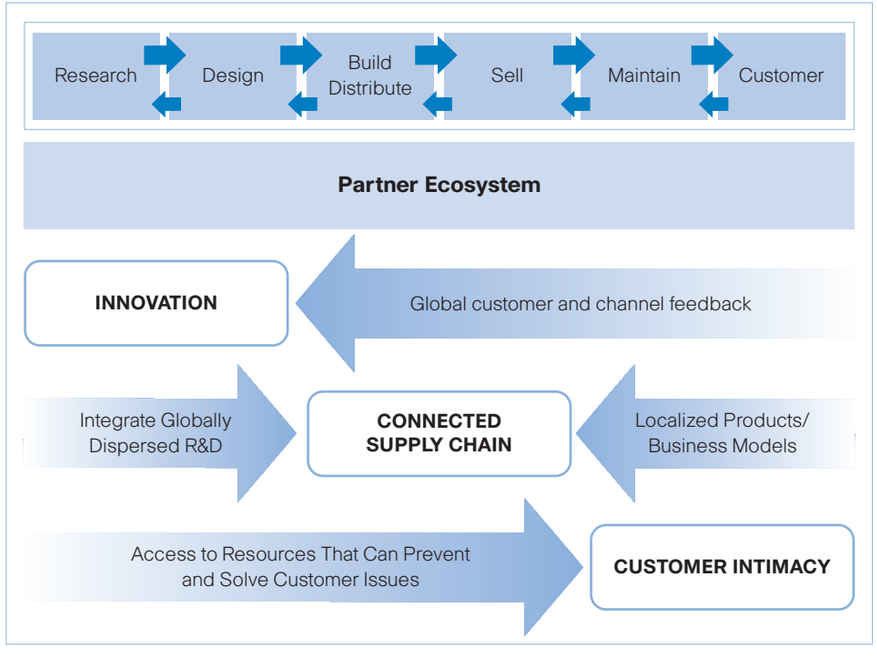


Figure 1 Bidirectional flow of information in next-generation manufacturing ecosystem. Cisco, 2005.

While goods flow from left to right, information moves in both directions and across traditional functions and organizations. Each value chain includes multiple partners and customers, with information flowing between these different parties and across country and regional boundaries. In order to invest effectively in new products, the left side of the chain, where raw innovation occurs, is tightly connected to the right side of the chain, where customer interactions take place. The supply chain is, by definition, global and applies to all functions, not only to capital-intensive ones.

Moreover, research indicates that early adopters of these principles are benefiting financially and separating themselves from competitors. In fact, superior profitability can be enjoyed by creating value chains on a worldwide scale and mastering the complexities of global sourcing, manufacturing, and sales. Most manufacturing companies, however, have yet to establish the processes and methodologies that support a truly effective global business, as we see in Figure 2.





**Profiting from global value-chain capabilities**

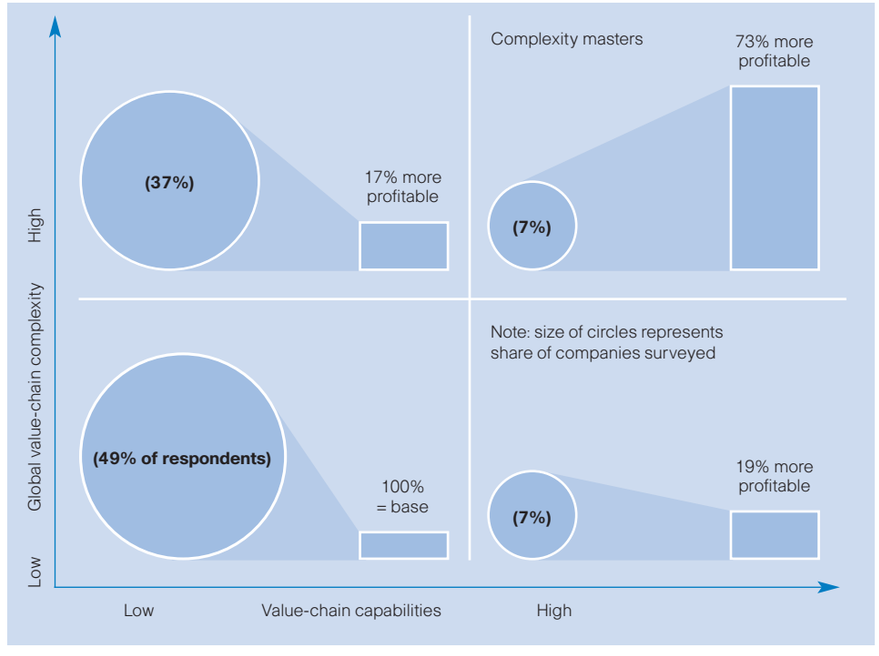


Figure 2 Complexity masters are more than three times more profitable than runner-ups. Deloitte, 2003; used with permission.

Working with leading companies in high technology and industrial goods, the Cisco Internet Business Solutions Group (IBSG) has developed a framework to describe the approach these first movers are taking. It consists of three building blocks:

- **Customer intimacy** allows organizations to differentiate the customer experience in order to cross-sell, up-sell, and maximize loyalty.
- **Innovation** in new product development requires integration of inputs from multiple sources, including customers, suppliers, original equipment manufacturers, and in-house R&D.
- **Connected supply** embraces all company functions and relevant partner functions around the world, improving the flow of information to improve decision making and accelerate processes.

As Figure 3 illustrates, customer intimacy and innovation provide a platform to enhance revenues, while connected supply is aimed at cost reduction. While many organizations excel at individual pieces of this framework, truly successful, next-generation manufacturers link all three components to create a sustainable, competitive advantage. In fact, the essays in this book feature several companies that have developed such an overarching vision and painstakingly assembled the pieces needed to make it work.

**Next-generation manufacturing cycles**

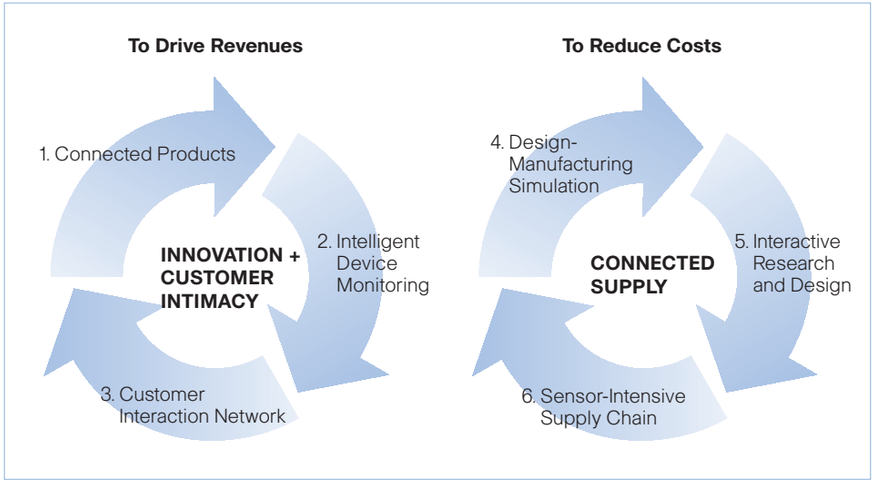


Figure 3 Integrated value cycles improve profitability. Cisco, 2005.

## Driving revenues by combining customer intimacy and innovation

As consumers demand more choice and flexibility, manufacturers need to understand their needs and requirements. In other words, they must achieve and sustain customer intimacy. Interactions with customers can be enriched by streamlining self-service and feedback processes, by training and developing customer-facing employees, and by taking advantage of the kinds of interactive technologies Cisco has deployed in its own sales and service operations. More sophisticated products, in fact, can be engineered to include new connectivity capabilities, which give valuable information on usage patterns and customer lifecycle events.





While information-capture and analysis are critical to developing customer intimacy, they are not enough. This information must then be translated into product and service innovation. Research by The Boston Consulting Group* shows that emphasis on R&D spending, as measured by R&D spend divided by total revenues, does not correlate with financial success. This makes sense if we consider that effective innovation and efficient innovation also are functions of how it occurs. Organizational or geographical silos make it difficult for companies to focus on innovation and tend to prevent cross-pollination of ideas.

Rather, innovation needs to develop organically from multiple sources within the extended global value chain. Ideally, all of the potential sources of innovation—customers, suppliers, original equipment manufacturers (OEMs), and in-house R&D—need to be embraced, because each one uses, or contributes to, the manufactured goods and will have a perspective on how they can be improved. Emerson, for example, has outsourced a number of noncustomer-facing manufacturing activities to focus on its core strengths. It uses a lower-cost Chinese team to design a new generation of products, build them in China, and ship them to configuration centers around the world for customization according to local requirements.

Leading manufacturers have already put this combination of innovation and customer intimacy into action, using three approaches:

- **Connected products.** Seamlessly connecting basic products to services opens a vast range of possibilities for manufacturers. The Apple iPod together with iTunes pioneered this approach to create a legal, cost-effective, easy-to-use, one-stop environment for end users. As a result, Apple enjoyed 85 percent market share in the music data download market and, with a "halo effect," increased Apple's computer sales by 26 percent. In fact, Apple is evolving into the platform of choice for Web-based personal content management. Companies that capitalize on this kind of product differentiation can expect to command a price premium of up to 15 percent, based on IBSG analysis.
- **Customer Interaction Network.** In an effort to improve the customer experience at every touch point, leading manufacturers are deploying Customer Interaction Networks

* *Peak Performance in Innovation—Rules for Success for R&D Management in the Manufacturing Industry*, Boston Consulting Group, 2003.

to enable lifecycle support across a complex array of services, delivered by OEMs and channel partners. Cisco, for example, has harnessed technologies such as IP-based communications to migrate all of its call centers into a virtual contact center. The new network will give customers a unified experience across all channels over which they choose to communicate—the Web, telephone, e-mail, or in person—and across each kind of interaction, from sales to customer service. The results of the project dramatically affect the bottom line. In addition to enhancing the customer experience, Cisco created significant savings through productivity benefits while decreasing average talk time by more than 30 percent.

- **Intelligent Device Management (IDM).** The remote management of products has evolved from basic monitoring to sophisticated performance management and information analysis, using intelligent devices attached to products at customer sites. GE Healthcare has implemented IDM in its medical equipment, including MRI and X-ray machines, computed tomography used for CAT scans, and other diagnostic equipment. The technology allows the company to monitor its devices, track operating parameters, perform expert diagnostics, and provide proactive maintenance and support. All of this results in improved reliability and serviceability of products, benefiting both GE Healthcare and its customers. By reducing hospital repair times, GE Healthcare has cut downtime by 40 percent, improved hospital productivity, and added US$100,000 in revenue as a result of its IDM capabilities. For GE Healthcare, IDM has created opportunities for new, value-added services that have helped it double service revenue.

### Controlling costs through connected supply

The cost containment part of the next-generation manufacturing framework focuses on the supply cycle. Unlike traditional approaches to supply-chain optimization, which concentrate on processes related to component and product manufacturing, and delivery, connected supply includes all core company functions, across all geographies. Fundamentally, connected supply is about improving the flow of information among all stakeholders, while providing real-time visibility into the information they need to perform their roles.





Such globalization does not require so much rigid standardization of functions or business processes as it does a precise definition of how partners should interact—and which information needs to be exchanged to ensure that best practices are implemented around the world. By doing so, globalization allows for faster, more inclusive decision making. It speeds up manufacturing and supply processes, without losing the specific advantages of different regions across which the supply chain might be spread.

A number of leading organizations have embarked on initiatives to deliver connected supply benefits, using technology to improve design, collaborate on R&D and engineering, and manage their supply chains:

- **Simulated manufacturing environments.** To drive global adoption of design and manufacturing processes, leading players are creating simulated manufacturing environments that enable rapid propagation of best practices and real-time collaboration. Nissan, for example, uses laser technologies to scan an existing factory floor, creating an electronic blueprint that can then be optimized, using simulation tools, and quickly replicated. By creating factory layouts and flows following the same set of rules, the time and cost required to design and build new factories can be significantly reduced. Boeing also uses integrated, computer-aided design tools to simulate how its 787 aircraft will be assembled, operated, and serviced, long before the aircraft is built. As a result, it expects to reduce development costs by up to 40 percent, improve fuel efficiency up to 10 percent, and create an aircraft that is much easier to maintain.
- **Interactive R&D—global, virtualized engineering.** Boeing is teaming up with more than 20 major partners to produce its next-generation 787 aircraft. Two-thirds of the 787 will be designed and produced by Boeing's partners, who are geographically distributed across four continents and 10 time zones. To do this, Boeing built a global collaboration design environment using a vast IT network that enables distributed teams to interact as if they were sitting in the same room. For instance, engineers can exchange design information, 3-D models, and reusable parts with real-time voice and video communications across a secure network. Instead of working on multiple, duplicate, and often unsynchronized data,

engineers use a single, shared database, ensuring that designs will work together. Using this interactive R&D environment, Boeing has committed to accelerating its time-to-market by 25 percent to 30 percent while lowering development costs by more than 20 percent. For the 787 aircraft, this represents more than US$1 billion in savings.

- **Sensor-intensive supply chain.** As they become more and more reliant on contract manufacturers and third-party logistics firms, manufacturers are finding it increasingly difficult to manage complex, global supply chains. Recent studies suggest that 3 percent to 4 percent of sales, and up to 25 percent of operating costs, are lost because of supply-chain inefficiencies. To counter this problem, leading manufacturers are deploying a variety of sensors to gather location, temperature, tampering, shock, and other information across the supply chain, allowing them to react faster and better to challenges. For example, CEMEX faced high transportation costs and spoilage as customers repeatedly changed their orders and delivery schedules. Using global positioning system (GPS) sensors mounted on cement trucks and linked to a central control center, CEMEX can now reroute trucks dynamically, based on up-to-the-minute information about changing customer requirements. As a result, CEMEX reduced delivery time from three hours to 20 minutes, cut the number of delivery trucks by 35 percent, trimmed operating costs by US$100 million, and improved on-time delivery.

In our experience, the sensor-intensive supply chain also changes the way a company sells. By improving visibility across the supply network, companies can quickly provide support centers with more accurate information, helping to increase customer satisfaction and loyalty while setting the stage for future sales. Even more important, the sensor-intensive supply chain helps to break down the boundaries between different product silos, organizations, and departments. Information about products and customers flows more easily, enabling more efficient cross-selling and faster reaction to customer preferences, which in turn translates into superior returns.





## The shifting global landscape necessitates next-generation manufacturing

By adopting these strategies, manufacturers can take advantage of the large-scale market transition we see unfolding, driven in particular by low costs in emerging economies such as China and India. This landscape has supported rapid growth, which generates money for investment and increases the affluence of the domestic economy. The result is a virtuous cycle where investment leads to greater export capability and increases domestic consumption, which in turn fuels further growth.

The magnitude of this shift is startling. Goldman Sachs suggests that by 2039, the economies of Brazil, Russia, India, and China—collectively known as the BRICs—together could be larger than those of the G6.*

Data from the 2002 U.S. Census Bureau indicate that imports from low-cost countries** to the United States accounted for more than 20 percent of U.S. consumption of motor vehicles, electrical equipment, and household appliances, along with approximately 25 percent of computers and peripherals and almost 30 percent of general electrical equipment.

The growth rates for imports from the BRIC economies, and countries that neighbor industrialized regions, are in double digits. Neighboring economies include Mexico in relation to the United States; and Poland, Slovakia, Czech Republic, and Hungary (known as the Visegrád states) in relation to Europe. Even goods requiring more sophistication, such as aerospace parts or medical instruments, are increasingly imported from outside traditional industrialized nations.

As a result, we now see increased competition among emerging markets. For instance, car manufacturer Kia is building a plant in northern Slovakia, at which it plans to produce 200,000 cars per year for the European market beginning in late 2006. Kia will work with 10 of its key suppliers at this new production facility, and the cars will cost 15 percent less to produce than those made in formerly "low-cost" Korea.

Boeing already operates its largest foreign engineering center in Moscow, where 1,000 engineers work on commercial and integrated

* *Dreaming with BRICs: The Path to 2050*, Dominic Wilson, Roopa Purushothaman, Global Economics Paper No. 99, GS Global Economics Website, 2003. G6 includes France, Germany, Italy, Japan, United Kingdom, and United States.

** Sample consisting of 11 countries: Brazil, China, Czech Republic, Hungary, India, Indonesia, Malaysia, Mexico, Poland, Russia, and Thailand.

**The shifting global import/export landscape**

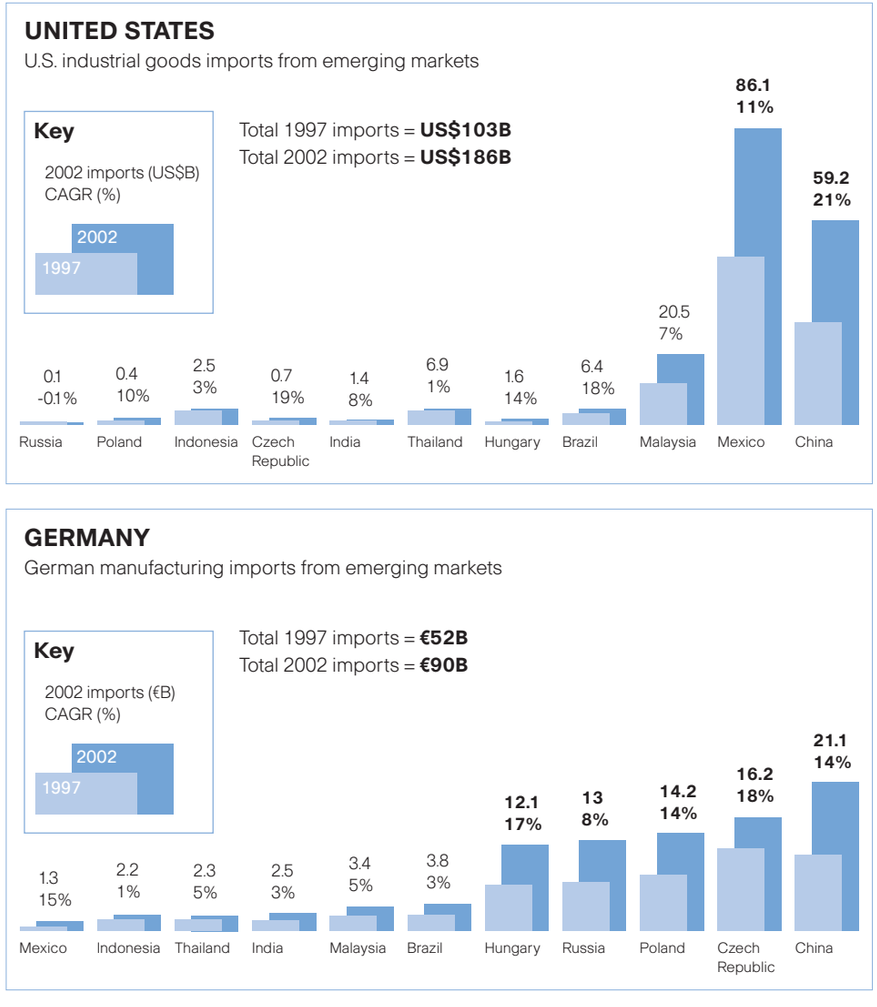


Figure 4 Winners of the game: low-cost Asia and neighbor regions (Mexico, Eastern Europe).

Note: NAICS = North American Industry Classification System.
CAGR = Compound Annual Growth Rate.

Source: U.S. Census Bureau; Statistical Office of Germany, 2003.





defense system projects. Some 300 Russian engineers are assigned to Boeing's next-generation 787 Dreamliner, cooperating with their peers in the United States. Most U.S. high-technology firms are opening substantial R&D facilities in China.

But BRIC growth is driven not only by exports and outsourcing. Many underestimate the scale of domestic consumption. China, for example, ranks first in the world in market volume for refrigerators and air conditioning, second for energy, and fourth for chemicals and packaging.* According to Goldman Sachs, compared to domestic growth, the net exports of BRIC countries have been a relatively minor contributor to their overall growth. Many in so-called developed countries would be surprised to know that the rate of technology adoption inside the BRIC countries has, in many instances, surpassed that of the rest of the world. While the growth rate of global cross-border Internet traffic has slowed, it continues to increase in these regions.** In 2005, for example, inter-regional (between regions) traffic climbed 64 percent in Asia and 70 percent in Latin America, while intraregional (within region) traffic increased 102 percent in Asia and 336 percent in Latin America.***

No global manufacturer can afford to ignore these markets. A recent survey of large U.S.-based manufacturing multinationals shows that many plan to start or expand operations in emerging economies over the next three years—not only sales and marketing, but sourcing, R&D, engineering, and manufacturing (see Figure 5).

Many manufacturers are developing product segmentation strategies for these markets. GE Healthcare's new HF Advantage X-ray machine was "designed in India for India" and is regarded as the first in a line of value-for-money products scheduled to be rolled out in other emerging economies. Such segmentation, however, is not completely straightforward. GE Healthcare is finding that buyers in developed economies are also showing interest in using these products as an alternative to more expensive equipment whose advanced features many regard as superfluous. This latter trend underlines the need for careful market management and close monitoring of local customer requirements. As customers see an ever-widening selection of goods and

* The Boston Consulting Group China Database, 2004.

** Doubling approximately every two months in 2000, it took one year to double in 2003/4. Source: International Telecommunication Union, Strategy and Policy Newslog, October 7, 2005.

*** Source: International Telecommunication Union, Strategy and Policy Newslog, October 7, 2005.

**Expansion of U.S.-based multinational manufacturers into emerging markets**

| | CHINA | MEXICO/CENTRAL AMERICA | EUROPE (WEST, CENTRAL, EAST) | INDIA |
|---|---|---|---|---|
| Marketing/ Sales | 56% | 47% | 40% | 23% |
| Sourcing | 57% | 26% | 14% | 21% |
| Manufacturing | 38% | 25% | 10% | 12% |
| Engineering/ R&D | 26% | 9% | 10% | 14% |

Figure 5 Survey of 226 U.S.-based manufacturing multinationals with combined revenues of around US$500 billion, showing percentage of respondents planning to start or expand their operations in emerging economies over the next three years.*

services at competitive prices, and a larger variety of channels from which to purchase them, it becomes a buyer's market. No longer content to pay for mass-produced, generic goods, buyers are increasingly demanding more customized products, which leads to greater manufacturing complexity. We see this now in the automotive sector. In 1982, the Mercedes Car Group produced nine models; over a decade later, in 1993, it offered just 10. By 2004, however, the number of choices had climbed to 25. Worldwide, the number of car models increased 47 percent from 1990 to 2003, and an additional 23 percent are expected through 2015.** LG Electronics clearly demonstrated its understanding of customer needs with its F7100 Qiblah mobile phone, which is designed for, and marketed to, Muslim customers. Because photographs carry a cultural stigma in the Islamic world and prayer service is a cornerstone of Muslim religious practices, the F7100 does not have a built-in camera. Instead, it contains an embedded compass device that points to Mecca, and also features a prayer-time alarm.

* *Growing the Global Corporation*, Deloitte Research Global Manufacturing study, 2005.

** McKinsey RACE Automotive & Assembly Extranet Survey, 2004.





## Putting the building blocks together

In essence, the manufacturing sector must defy conventional economic wisdom by increasing customization while reducing prices. The most successful companies will do this by excelling in all three components of connected manufacturing: customer intimacy, innovation, and connected supply. They will master increased complexity and achieve the difficult balance between standardizing processes and products internationally, and responding flexibly to regional needs. They will reconfigure global supply chains constantly, in real-time, and will avail themselves of the cost advantages and skilled talent pools in emerging economies.

As you will read in the essays from this book, companies that embrace these principles are already reaping rewards in terms of improved profitability. The pioneers in this book are not simply looking for lower-cost sourcing—they're creating entirely new models. The smooth passage of information across the extended value chain allows them to use new customer approaches in both developed and emerging markets, and to innovate more rapidly and efficiently.

Now is the time for companies to embrace the core principles of next-generation manufacturing and use them to achieve a sustainable and competitive advantage. We hope these essays will provide inspiration and some insight into how this can be accomplished.

DIRK SCHLESINGER

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SENIOR DIRECTOR, MANUFACTURING,
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Dr. Dirk Schlesinger brings 14 years of management consulting experience to his role as leader of the Cisco IBSG Global Manufacturing Practice. Before joining Cisco, he was vice president and partner of The Boston Consulting Group (BCG) in Munich and Washington, D.C. His portfolio of assignments includes strategy and operational work for clients in the energy, utilities, industrial goods, and financial services sectors. Prior to BCG, he worked in the engineering departments of Airbus and MTU Aero-Engines.

A German citizen, Schlesinger has a Diplom-Ingenieur in aeronautical and astronautical engineering from Stuttgart University, a master's degree in business administration from the University of California at Berkeley, and a doctorate from the College for Mathematics and Information Technology at Mannheim University.

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A Dutch citizen, Kuppens studied computer science, mathematics, and business administration in the Netherlands. He completed his master's degree at the University of Utrecht (NL).



# 1 COMBINING CUSTOMER INTIMACY AND INNOVATION

The manufacturing sector must defy conventional economic wisdom by increasing customization while reducing prices. The most successful companies will do this by excelling in connected manufacturing. They will master increased complexity and achieve the difficult balance between standardizing processes and products internationally, and responding flexibly to regional needs.

EMPHASIS ON CUSTOMER SATISFACTION is part of our DNA and a critical component of the culture.

**Joseph Pinto**
SENIOR VICE PRESIDENT, TECHNICAL SUPPORT SERVICES, CISCO, UNITED STATES

# Using technological innovation to deliver world-class customer support

CISCO IS THE WORLDWIDE LEADER in networking, developing communication products used for transporting data, voice, and video across private networks as well as the Internet. Founded in 1984, Cisco employs more than 48,000 people worldwide and reported revenue of US$25.8 billion worldwide for fiscal year 2005. The company employs more than 11,000 engineers and dedicates more than US$3.4 billion annually to research and development.

In recent years, Cisco has added a number of advanced technology offerings to its core family of routing products and switching products. These products—covering enterprise IP communications, home networking, optical networking, security, storage-area networking, and wireless technologies—are each expected to constitute $1 billion in market opportunities for Cisco. These advanced technologies present a number of new demands on Cisco's business, including the need for high-quality technical support across a diverse set of products and solutions, and the ability to support customers' increasingly sophisticated networks quickly and accurately.

## Introduction

THE EVOLUTION OF CISCO'S CUSTOMER-SUPPORT capability over the past decade reflects the sweeping changes that have overtaken the customer-management industry as a whole. Building an effective customer-support infrastructure is no longer simply about staffing call centers to handle voice traffic—it is about harnessing a wide range of voice, data management, and information-sharing technologies to empower both customer-support agents and customers. Pursuing this goal has produced significant business results for Cisco:

- Consistent, repeatable, closed-loop feedback process that helps the Cisco Development organization make informed decisions about improving the reliability, availability, serviceability, and usability of Cisco products
- Standardized 24-hour global customer-support capabilities
- Ten years of increasing customer satisfaction ratings

These advances have not always been easy, and we have had to tackle a range of technical and organizational challenges. Our efforts to improve customer support began in the early 1990s, at a time when the company was growing so fast that we were, quite frankly, unable to meet customer-support needs. We initially addressed the problems using our own IP-based technologies—moves that put us at the forefront of contact-center thinking. Over time, we realized many of the solutions we had implemented in the technical support department could be applied more broadly across Cisco. That belief resulted in an all-embracing, combined Web and call-center approach, which uses Internet-based technologies to deliver a consistent, unified customer experience provided by skilled agents capable of handling any kind of interaction.

**We realized that technology advances could provide us with the ability to scale our support function effectively while offering the high level of service our customers demanded.**

We believe this Customer Interaction Network will allow us to realize goals that have long been discussed in the customer-support profession but in practice rarely achieved. Any organization with a sizable customer base knows that handling customer inquiries is an extraordinarily complicated business. For starters, customers communicate using a variety of methods—from e-mail and Web-based forms to fax and telephone. Sometimes there is a need to use more than one channel simultaneously—a customer searching for an answer on the Web, for example, may want to talk to an agent at the same time—and to employ new kinds of collaborative tools. Managing these different communications channels places a new level of demand on agents while presenting a number of technical challenges. Few organizations have succeeded in developing the necessary infrastructure.





Second, depending on the nature of a customer call, resolving the inquiry may present additional challenges. Agents may be asked to find information held in incompatible systems distributed across multiple locations, which presents significant access and integration issues. If agents cannot find the information in question, they need to know to whom to refer the query. In effect, they require a transparent organizational structure and a very open, flexible information infrastructure. This is precisely what we have been building at Cisco over the past 10 years in an effort to make sure we provide a support capability that satisfies our customers.

This emphasis on customer satisfaction is part of our DNA and a critical component of the culture. From our early days as a high-tech start-up, the leadership at Cisco devoted time and energy to our customer focus, and the fact that we have an entire department within Cisco called Customer Advocacy is a testament to that effort. As a result, there is a strong sense of personal accountability around customer satisfaction, supported by metrics to encourage the right employee behaviors. We have had a formal system of measuring customer satisfaction for more than 10 years, and each employee who has direct contact with the customer or not is compensated in part on the basis of customer satisfaction. I like to refer to customer success as the “high-order bit”—in other words, it’s the number one priority for our organization.

### The early years: Internet technology drives a vision of quality Web-based customer support

In the early 1990s, Cisco was growing at such a rapid pace that scaling customer support to meet our expanding customer base became a management imperative. At the time, we were operating a fairly typical high-tech customer-support operation, in which any customer experiencing a product issue called us directly for technical support. Consequently, as our business grew rapidly, so did our need to hire highly skilled technicians, who were very scarce at the time. These pressures on our support system resulted in a drop of more than 20 percent in our overall customer satisfaction scores, and as we attempted to scale our business to meet the soaring levels of demand, it quickly became clear that we simply could not continue along the same path.

This situation occurred at a time when companies were first experimenting with the use of the Internet to support their key business functions. At Cisco, we obviously had something of an inside track. Our

people understood the burgeoning Internet technologies better than anyone else in the industry, and this drove much of our own internal experimentation. We started with what today would be viewed as a very rudimentary capability: a bulletin board providing customers with self-service access to a published list of updates of software bugs identified in our products. This willingness to share product defects with customers in an open and forthright way also differentiated us from our competitors. From these humble beginnings on the Internet, we realized that technology advances could provide us with the ability to scale our support function effectively while offering the high level of service our customers demanded.

We also recognized that we were fortunate to have a customer base that was skilled in the newly developing areas of Internet technology. Their technical savvy meant that most of our customers preferred to use the Web as their primary means of customer support, a preference that was repeatedly confirmed by our customer satisfaction

### Clear customer-service vision

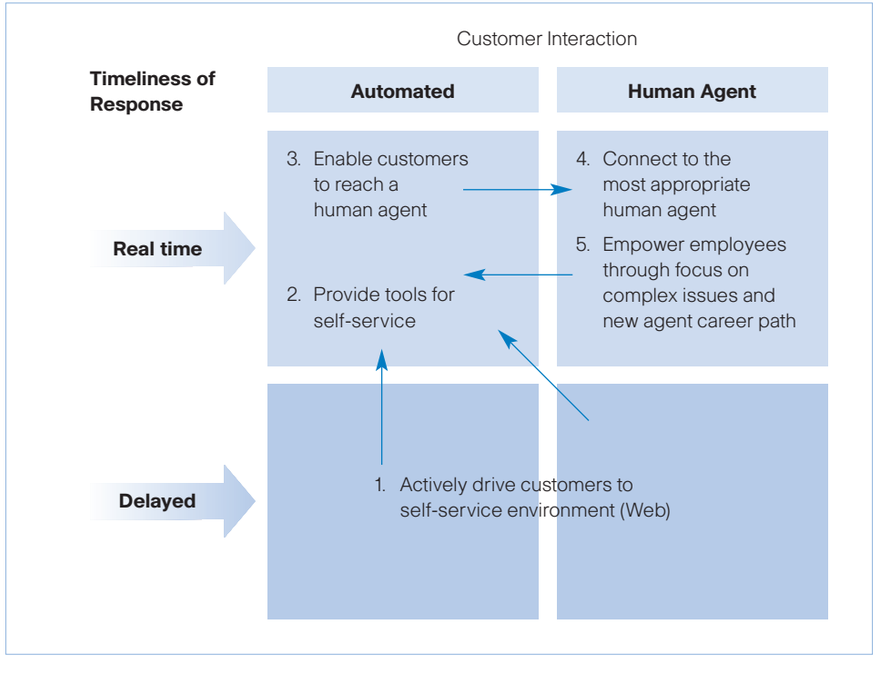



Figure 1 Cisco, 2002.





measurement systems. As our capabilities grew, we implemented a series of initiatives to provide a high degree of self-service while still offering rapid and easy access to engineers with the requisite skill sets. When customers bought our products, for example, we educated them on how to access Web-based help, and we invested the resources to capture, document, and share solutions for the most common technical problems on our Cisco Website. We also took advantage of the capabilities of our own technology infrastructure. For example, we built a capability for our customers to open tech-support cases online and allowed those customers to speak with engineers more quickly than customers who simply picked up the phone to call. This capability reinforced the behaviors that we were trying to encourage—outstanding customer support through the use of a rich set of tools and content available via our Website, backed by a high-quality engineering staff motivated around customer success.

**Today, 79 percent of support cases are resolved directly by customers using the content and tools we offer via the Web.**

Our successes have been significant. Today, 79 percent of support cases are resolved directly by customers using the content and tools we offer via the Web. We are unique in that we have a team of more than 50 people dedicated to ensuring that we provide the most up-to-date and accurate support information on Cisco.com. Any concerns that customers would be unhappy being asked to troubleshoot their own problems online have proved to be unfounded—our Web-based self-service has actually had a positive influence on customer satisfaction, which has been steadily increasing since the early 1990s. Not only are the Web-based solutions quick, but they are also available around the clock, which increases customer self-sufficiency and productivity. In addition to improving satisfaction, we have benefited internally: the technical support department has made process changes that have created savings based on these self-service strategies.

Not surprisingly, we have learned a lot along the way. First, we quickly realized that our customer-support metrics and incentive systems needed to be realigned in order to realize benefits from our strategy. After all, it makes no sense to reward support staff based on the number of calls they handle—a common call-center metric—if our

goal is to maximize the use of customer self-service. Second, by using the Web and the phone together to guide the customer to a solution, we started to appreciate that the role and skill sets of the frontline agent had evolved well beyond simply answering the telephone. Unlike agents in traditional call-center environments, a Cisco agent is expected to help coach customers about how to solve their problems using all the Cisco resources available to them. As a consequence, our agents are building baseline skills in a number of aspects of our business and have multiple career path options within the organization. This is very different from the traditional contact-center environment, where managing attrition is a key management challenge.

### Moving beyond technical support

The lessons, innovations, and successes of the technical support department caught the attention of leaders across Cisco. They realized that the company could capitalize on this customer-support progress by applying the approach to the rest of Cisco.

IT standardization has been a Cisco trademark since the mid-1990s, when the company first decided to implement a single Oracle enterprise resource planning (ERP) system for the whole organization. By 1997, Cisco had also standardized its whole IT data infrastructure. Not surprisingly, the network was 100 percent TCP/IP, using our own technology.

These investments provided a strong foundation for us to build out our Internet capabilities across the organization. In 2003, we completed the migration of all Cisco voice communications to the same IP infrastructure, including our customer-support contact centers. Because of this, we were one of the first companies in the world to adopt a full IP-based call-handling infrastructure—a business transformation capability that we are now able to fully exploit as part of how we interact with our customers.

While Cisco's explosive growth allowed for a great deal of innovation, it also created IT-management issues. Many IT tools were developed by independent teams, and while they all tapped into the standard ERP system, they often duplicated their efforts and were often unable to share information and resources. In short, we had no structured method to fund and track central initiatives. In early 2002, we realized that we needed to focus on executing cross-functional programs. We established the Business Process Operating Council (BPOC), composed of senior executives from across Cisco, to sponsor and coordinate these major initiatives across the company.





This forum ultimately recognized that the customer-support innovations developed by the technical support department could be applied much more broadly to the rest of the Cisco organization. Thus, the concept of the Customer Interaction Network initiative was born.

### The Customer Interaction Network: Transforming the customer experience

As a first step to re-creating our successes in postsales technical support, we examined what our customers actually experienced when they contacted us. Cisco's approach to customer contact, like that of many other large organizations, has evolved over time, and because it was driven by the various departments responsible for working with customers, it was piecemeal and inconsistent. Prior to implementing the Customer Interaction Network, for example, customers worldwide had to choose from more than 500 telephone numbers in order to contact Cisco.

**Business problem: Cisco perspective (April 2004)**

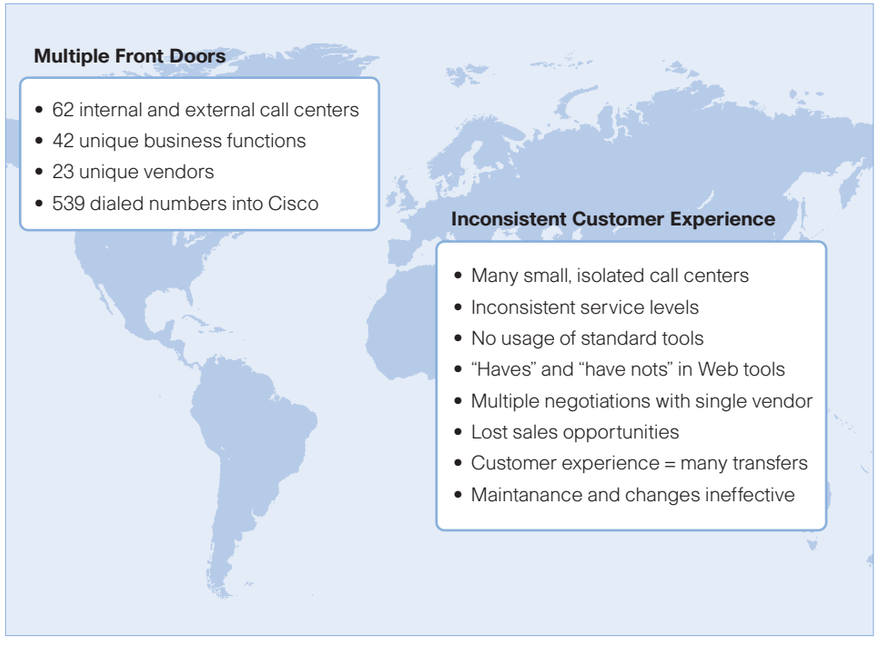



Figure 2 Cisco, 2006.

In addition to frustrating our customers, this lack of consistency was adding unnecessary costs to our business. We were not realizing economies of scale with our partners, who were often the prime contact points for customers. In addition, we were not maximizing our substantial investments in the Cisco.com Website as part of the customer experience. We set about developing a plan to tackle this problem and concluded that we needed a single, responsive frontline capability, regardless of the reason customers were contacting us. We also wanted to move away from using a machine to answer a customer call, because customers told us that automated response systems were a source of significant frustration.

Our goal, therefore, was to have all calls answered by a knowledgeable agent who could accurately answer the inquiry on the spot—in practical terms, to offer a high level of first-call resolution—and, where that wasn't possible, to refer the customer accurately to the right resource within Cisco. But how could we build a frontline department that did not simply transfer every call it received to another part of the business? And furthermore, how could we get all the different business functions within Cisco to appreciate the need to work together to drive overall customer-support success?

This is where the Customer Interaction Network team turned again to the BPOC to get the initiative off the ground. The next step was for the team to document the most important customer-facing processes across the organization, focusing on *how* to answer the customer question rather than on *what* the actual answer might be. The team built these processes and solutions into an internal knowledge-management system called Information System for Accelerated Access to Cisco (ISAAC), which all frontline agents could access.

A key component of this approach involves codifying all the major customer-facing processes across Cisco. If the process needs to change for some reason, we can do it once within ISAAC, quickly and easily, and all frontline agents adopt the new process immediately as it populates the system. The ISAAC capability also provides accurate, real-time information for agents to share with the customer, as well as ongoing learning for the agents as they continuously use and incorporate new information.

While we were documenting the customer experience, we also captured the appropriate methods to use in answering customer inquiries via the resources available on Cisco.com. Using this methodology, our agents can show customers how they can find





answers to their questions online—a practice customers can employ on their own the next time they experience a similar issue. This is just one example of how the power and flexibility of the IP network really come into play. Likewise, we can refer any conversation to literally anywhere within the organization without losing information the customer has provided. In addition, at the push of a button, we can invoke Web collaboration technologies and phone collaboration technologies to help resolve customer questions quickly and easily.

After a pilot implementation of the Customer Interaction Network, we are now in full-scale rollout of the capability across the globe. We estimate that our frontline Customer Interaction Network team will handle in excess of 1.5 million customer calls worldwide this

**Cisco is deploying a common frontline organization**

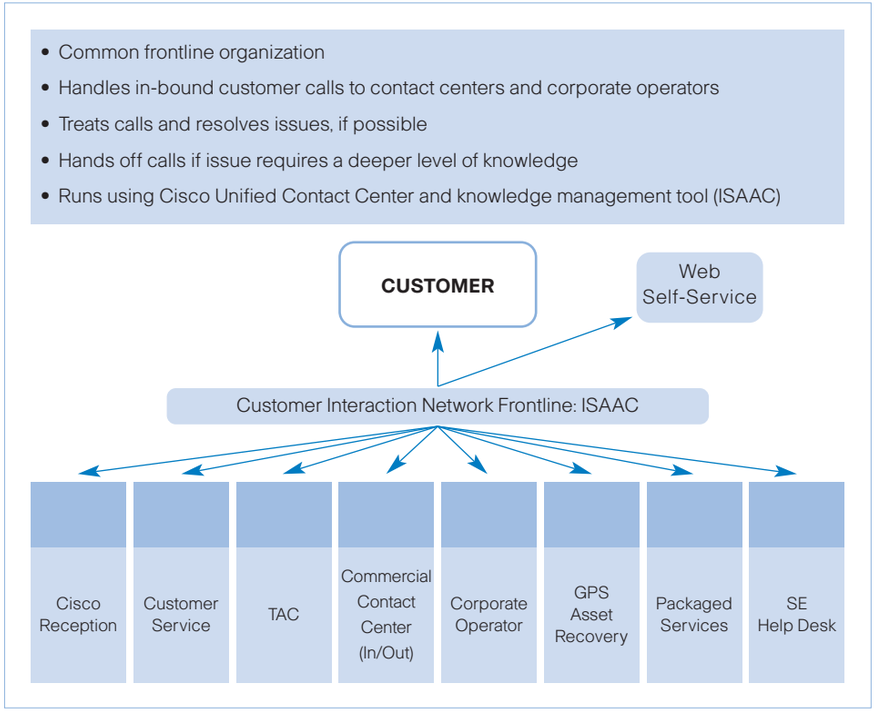



Figure 6 ISAAC = Information System for Accelerated Access to Cisco.
TAC = Technical Assistance Center.
SE = Systems Engineer.
Cisco, 2006.

fiscal year. Our initial implementation experience has already exceeded expectations, and customer feedback in both Europe and in the United States has been very positive. While enhancing the customer experience is the primary objective of the initiative, an additional benefit is that we expect to save US$30 million in operating costs over the next four to five years as a result of this capability.

The innovations we have pioneered in providing customer support have already generated significant business results. In addition to the financial and productivity savings from optimizing our communication channels, we standardized our support processes and methodologies to take advantage of economies of scale and to replicate best practices around the world. From an employee-management perspective, we have taken steps to address the industrywide problem of high turnover in contact centers by transforming the role of our service agents, creating highly skilled roles with meaningful career development, built on a foundation of a reward system that reinforces our customer satisfaction priorities. And most important, we offer a consistent, 24-hour customer experience, providing fast, informed resolutions to questions customers ask using whichever channel they prefer. At Cisco, our mission centers on using technological innovation to transform the way we work, live, play, and learn. We believe that the Customer Interaction Network demonstrates how powerful that transformation can be.

**JOE PINTO**

SENIOR VICE PRESIDENT, TECHNICAL SUPPORT SERVICES, CISCO, UNITED STATES

Joe Pinto is senior vice president of technical support services at Cisco, the worldwide leader of networking for the Internet. Pinto's 2,000 employees around the globe provide Cisco customers and partners with a full range of world-class support services, including expert technical assistance over the telephone, on-site and spare-part logistics, CCIE certification, and a wealth of Web-based technical support tools and documents on the Cisco Technical Support Website.

Pinto joined Cisco in February 1991 and has successfully evolved the traditionally phone-based technical services function by developing an industry-leading Web-based support component. As a result, 79 percent of all Cisco customer technical support issues are solved online. This has allowed Cisco to realize significant financial savings and time efficiencies by using the Web for customer care, workforce optimization, supply-chain management, and e-learning.

Pinto shares his knowledge of service and support strategies via industry conferences and industry articles including *In Search of a New Value for the Support Operations* (Financial Times, July 2006), and *Maximizing Customer Value Through Support Information* (CRM magazine, May 2005). He has delivered the keynote address at Help Desk Institute, Interlog, and Service & Support Professionals Association events. Pinto is active in philanthropic work, serving on the board of the Cisco Foundation, and is chair of the Engineering Industry Advisory Council at San Jose State University. Under Pinto's direction, Cisco has also partnered with Wichita State





University to develop an on-campus Cisco Technical Center, further supporting the critical relationship between universities and the high-tech industry. He has also established the Pinto Family Foundation to assist northern California health, education, and welfare groups.

Pinto holds a bachelor's degree in business from Golden Gate University in San Francisco, California.

FUTURE SUCCESS will require the ability to meet customers' increasing demands for greater speed, efficiency, and accountability.

**James G. Berges**
PRESIDENT, EMERSON ELECTRIC CO., UNITED STATES

# Driving business innovation with enabling technologies

EMERSON IS A GLOBAL MANUFACTURER of technology products that address process management, industrial automation, electronics, and telecommunications. It has more than 100,000 employees around the world, and in 2004, the company's worldwide sales totaled US$15.6 billion. The business combines technology and engineering to provide innovative solutions for customers across a wide range of industrial, commercial, and consumer markets. Emerson's solutions include sophisticated process-control systems that help ensure efficient, safe, and high-quality production of everything from petroleum and chemicals to food products and pharmaceuticals. In addition, Emerson's reliable power technologies help safeguard the Internet, phone, and computer networks from electric power outages and disruptions.

WE PRIDE OURSELVES ON OUR INNOVATIONS in information technology. Recently, our company achieved a second-place ranking in *Information Week* magazine's annual list of the 500 best users of information technology. Our approach to IT has been shaped by a strategic shift in our business over recent years. We are using IT to develop more efficient ways to connect with suppliers, employees, and partners globally, and to meet the needs of customers more effectively by delivering greater visibility. Visibility provides a clear, competitive advantage in the global marketplace and delivers a positive impact on revenue growth. We are also using IT to improve our ability to manage growth, productivity, and research and development globally.

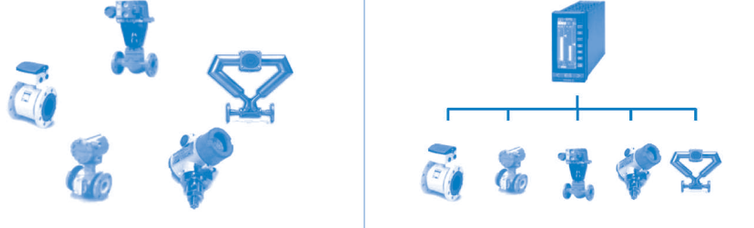
### Technology's changing role in our business

To understand the roles innovation and technology now play at Emerson, and the parts both will play in the future, it is important to

understand how our business has evolved. Fifty years ago, Emerson was primarily a domestic electric motor company with a union-avoidance strategy. Our competitors were General Electric Company, Westinghouse Electric Company, and others that had unionized facilities in Ohio and Indiana. The strategy developed back in the 1950s was to compete by having "better cost labor." So, we built factories in Paragould, Arkansas; Kennett, Missouri, and Ava, Missouri, and worked hard to keep them union-free so that we wouldn't end up with restrictive work rules and customer-service risks.

In the years following, Emerson grew by being best in cost. By 1990, despite being a US$9 billion global company, we were starting to run up against limits. In our core components market—motors, thermostats, pressure transmitters, and power supplies—we started to see low-cost competition coming from Asia and Latin America. We reacted to these new threats by building plants in Mexico and Asia to take advantage of lower costs and to serve those faster-growing marketplaces. Meanwhile, we began to invest heavily in R&D to move up the food chain. Instead of being just a component supplier, this investment allowed us to link these best-cost components together into

**The need to break the system influence**



Although devices were purchased individually...



Many devices were purchased as part of control systems with proprietary communication protocols.

**Without an industry-leading control system, further device penetration would be limited.**

Figure 1 Illustration of Systems View. Emerson Electric Co., 2004; used with permission.





a set of solutions for our customers. We became less dependent on the components themselves and more focused on adding value.

For example, at our Paragould plant, we produced 30,000 washing machine motors a day for Whirlpool, Maytag, and Electrolux. But our customers' needs began to change. They started to see the emergence in the United States of front-loading, a process, common in European-style washing machines, by which the machine operates at high speeds to wring out more water from the clothes before the drying cycle begins. They used less water, so as a result, they were very energy efficient. Moving from motor- and transmission-driven top-loading washing machines to a front-loading machine is not a trivial exercise, so these customers came to us for a total drive solution. We now provide not only the motor but also a system that enables the motor to operate over a wide range of speeds. You want to operate at low speeds while washing, then at very high speeds to wring out the water. We moved

**Evolution of intelligent field devices**

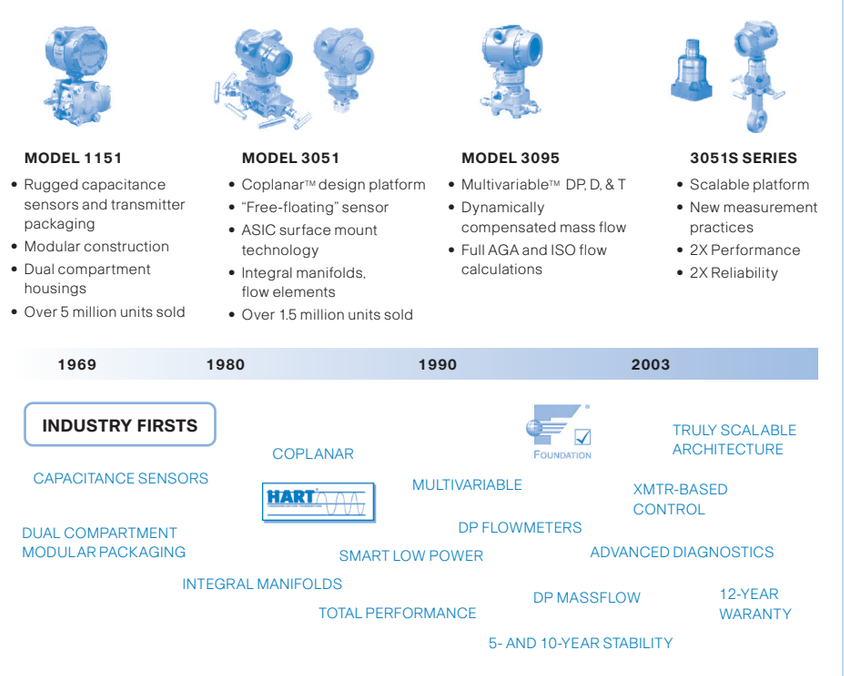



Figure 2 Illustration of how products are evolving to become more intelligent. Emerson Electric Co., 2004; used with permission.

from selling our customers a US$25 motor to selling US$80 worth of motor and controls.

Then, in 2000, came the collapse of the Internet bubble. This made it impossible to sustain our 44-year history of continuous growth in earnings per share, a record unequaled in United States industry. Emerson began outsourcing a growing proportion of non-customer-facing activities, which allowed us to focus on our core strengths. We used to make everything because we were the "best cost people"—we didn't think there was a single part of our motors, thermostats, or compressors we couldn't make better than everyone else. Now, as our business has matured, we have come to recognize it can be better to have somebody else make some of these parts for us. This has meant greater collaboration—both internally and with external partners.

### IT as a business enabler

Emerson uses IT in a number of key ways within the business. On a day-to-day basis, our service people carry laptops while on the road to manage their personal schedules, access technical support for maintenance, and to order spare parts. A number of our Emerson Retail Services employees use wireless mobile devices to call up design specs and diagnostic routines, eliminating the need to carry heavy manuals when out on a job. We also use IT to encourage collaboration, an increasingly important area for our business, in order to find new and better ways of sharing information, technical knowledge, and expertise on a global rather than local basis.

Our biggest use of IT, however, is on the design side of our business due to the global spread of our operations and designers. Web conferences ensure that every member of our design teams—regardless of location—can stay current with a project, provide his or her unique inputs, and develop a local version of a product. In many of our businesses, we literally design products around the clock, handing off the design to the next time zone every evening.

The fundamental challenge Emerson now faces is keeping our costs low while still remaining competitive in all products and solutions we sell. The end result is a hybrid model. On one hand, we strive to have the best-cost factories at the component level, which can be anywhere in the world. On the other hand, we continually focus on serving customers with solutions that are specific to local markets. For example, our DC power systems business provides 48-volt systems for telephone companies' central offices and wireless base stations. These products





are consumed worldwide, but every country and many service providers have their own standards. We found that there are some common elements, and we created global teams to agree on common specifications. Then, we designed a whole new generation of products with a global design team. We manufacture the building blocks in China and ship them to configuration centers in Mexico, South Africa, Slovakia, India, and China. At these locations, local design teams put the building blocks into systems that meet local customer requirements.

**Market adapted DC power systems based on standard units**

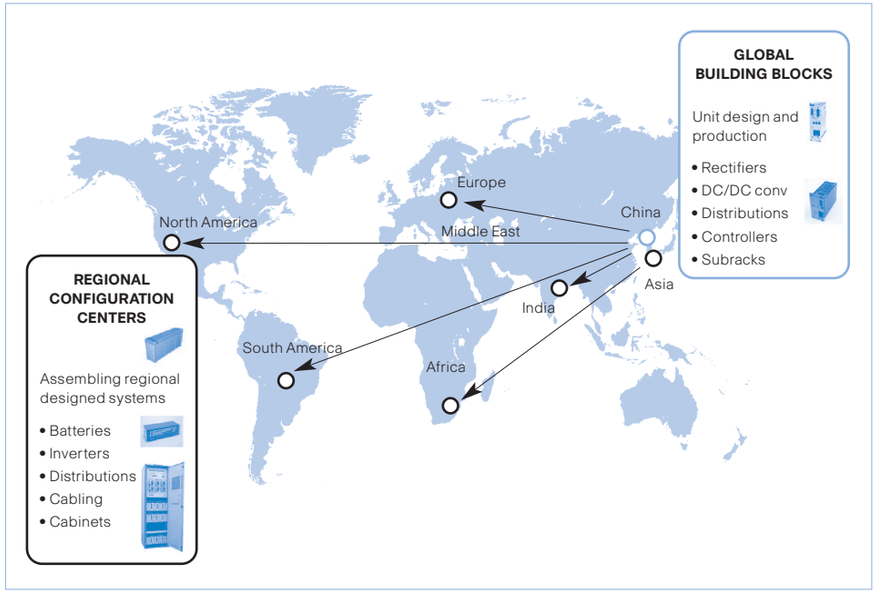



Figure 3 Illustration of Emerson's global footprint (DC Power). Emerson Electric Co., 2004; used with permission.

The DC power example is a good illustration of how important IT is in coordinating our strategies. The biggest place we are using IT is on the design side because the team comprises people from all over the world. We have a rigorous development process that requires conference calls at least weekly. Webcasts allow everybody—whether they are in China, Sweden, South Africa, or Canada—to be online and view pictures of products simultaneously.

Each team member wants to stay informed, so that he or she can develop a local version of the product and provide inputs about required voltages, frequencies, and other unique customer requirements. Everyone needs to be connected, so if someone says, "We've got our first-generation samples done, but we were unable to reach that temperature-rise requirement that the experts from Brazil wanted. How important is that?" the guys from Brazil can say, "Telefonica insists upon it, and they're a US$50 million customer, so we've got to do it." We also have vaulting for the drawings since we are effectively designing around the clock. As drawings are updated and changed by the design team in China, they are ready for review by team members in other parts of the world when they arrive at the office the next morning.

### Bridging the cultural divide

It wasn't hard to get agreement from everyone to work this way. Our business dropped by 40 percent between the first quarter of 2000 and the first quarter of 2001. The telecom and data center businesses collapsed. So we were obliged to change the way we did business.

When business was growing from 1998 to 2000, we made a number of acquisitions. We bought Nortel's and Ericsson's power businesses, and we left them both alone because they were doing great. We started to do some engineering collaboration, but we were not getting much traction because everybody was busy trying to keep up with a 30-percent growth rate. Yet, when business started to fall, we opportunistically bought into China when we acquired Huawei's power systems business. We paid US$750 million for a Chinese company with US$160 million in sales. Some people thought we were crazy at the time, but we established a foothold in the fast-growing Chinese market and gained access to more than 500 China-based power engineers. That is how we established the parallel design strategy and our ability to get rapid redesigns.

The biggest challenge was getting the China team lined up to assist the rest of the world. The global team was ready for the help, but the China-based operation was fixated on the Chinese market. It was a real challenge for the management team to say, "We need your help to take some of your resources and put them on global design projects." All China saw in the global designs was the likelihood that they would slow down their ability to innovate in their own market, where they were seeing price pressures that required rapid redesign responses.





The first product on which we worked together was a next-generation 50-amp rectifier. We told them they could not go off and do it themselves; they had to wait while designers and marketing people from around the world agreed on a global specification. We revised their design process by adding some marketing gates, such as pricing reviews and value mapping. A year later, they had a product they loved. It has been hugely cost-effective because we now have four times the volume in a single design. And the feature set of the 50-amp rectifier is very rich because know-how from Sweden and from Canada was built into the product development process. This has significantly improved the performance of these units.

### IT's role in other functions

Aside from design, broadband technologies have played an important role in supporting the day-to-day activities of our customers worldwide. For example, we have extended our service and solution proposition by setting up a 24-hour, seven-days-a-week call center in Manila, Philippines, to handle queries from oil and gas industry maintenance engineers working in the field. We have hired people with process-control experience who are fluent in many languages and capable of running diagnostics to help callers with their problems. Access to an FAQ database and technical specifications used by this team occur via broadband.

**The biggest place we're using IT is on the design side because the team comprises people from all over the world.**

Another example of IT's use within our business is procurement, where we are seeing a direct, positive impact on the bottom line. Historically, we were an organization of 60 or so independent divisions, each making its own decisions about what it bought, and where it was purchased. We were getting zero leverage. The biggest impediment to changing this situation was that we had 110 data centers running 63 different enterprise resource planning (ERP) systems. Just figuring out how much of a particular commodity we purchased was an enormous, manual task.

Today, we have a single, overarching data warehouse called the Material Information Network. It encompasses 63 ERP systems and interrogates them periodically to retrieve price and volume data from item records. It took a couple of years to get this rolled out, but now we can find, at the press of a button, not only how many die castings we are using, but also at what price and from which vendor. We are now working to add descriptive fields so we can break down die-casting data by type of alloy, and by mold size. Today, we can call up parts by manufacturer part number and examine price differentials being paid across different locations. This allows us to buy components at the best price within the global market, allowing millions of dollars of savings. The end game is to reduce the number of suppliers we use. So far, we have invested approximately US$25 million in this system, and we have already been able to realize cost savings of between 5 percent to 10 percent.

### What the future holds

We also see potential for IT in other areas of our business. We foresee significant potential for radio frequency identification (RFID), although it is currently a bit too expensive. Instead of wandering around a warehouse to get data, it would be ideal if the data were just there, immediately available via a Wi-Fi receiver. The richness of data available in an RFID tag also makes it a great productivity tool.

We are exploring other areas as well. Our Corporate Technology Group is closely following the evolution of wireless monitoring. A classic place you might use this is a factory, where active tags on badges help prevent unauthorized employees from entering a sensitive area.

**We have little doubt IT will help us increase productivity in the future.**

In the future, we believe our customers will place growing value on systems and total packaged solutions. Consider the oil industry, for example. When oil was US$11 a barrel, the oil companies had to restructure, eliminating thousands of control engineers, petroleum engineers, and process people. As a result, when they decided to upgrade or build a new refinery, they no longer had the people who could do it in-house. Initially, they turned to construction engineering houses, but then they realized that these suppliers just couldn't handle the control-system side.





So the oil companies got smart. They went to the marketplace and asked for help in designing processes, including breaking crude oil into new categories such as jet fuel and diesel. We now perform this front-end design work. Once we were just a measurement instrument business; now we are also a solution and service provider. This pattern seen in the oil industry will be replicated elsewhere as well.

Increasingly, customers will come to us for original design work, whether to design wireless telephone sites, or to design petroleum plant and power-generation facilities. As they do, they will start asking for operational and maintenance contracts. This has already happened in the telephone business. We manage Telefonica's power, from utility to chip, across most of South America. In Peru, we buy power on Telefonica's behalf from multiple companies. This power is used in all of Telefonica's central offices and cell sites. We have teams of people working within Telefonica's operations units, attending morning meetings where they talk about network problems. We are their power representatives, and, if there is an outage at a site, we roll out teams to find the problem and fix it.

We have little doubt that IT will help us increase productivity in the future. Already, we are getting significant productivity savings from our lean factories. By improving inventory turnover over the past five years, we have significantly improved our working capital ratios. We have freed up considerable space within our factories, and we are responding more effectively and efficiently to our customers' demands.

Already, we are working to build more and more visibility into our processes. Future success will require the ability to meet customers' increasing demands for greater speed, efficiency, and accountability. Tomorrow, our ability to engineer quickly with a "swarm engineering" effort—getting an order into the system, onto the plant floor, and into the customer's hands on time—will be a key competitive weapon. Equally important will be our ability to connect end-to-end order entry and fulfillment in ways we have never done before.

### Emerson: lessons on innovation

- Develop a deep understanding of customers' needs, and address them with innovative solutions
- Use innovation to change threats into opportunities
- If you believe, reinvest preemptively
- Use best-cost resources to speed the pace of innovation

**JAMES G. BERGES**

PRESIDENT, EMERSON ELECTRIC CO., UNITED STATES

On graduating from the University of Notre Dame in 1969 with a bachelor's degree in electrical engineering, James (Jim) G. Berges entered General Electric Company's manufacturing management program. He joined Emerson Electric in 1976 and returned to the corporate offices in 1989 as group vice president of electronics and, subsequently, as executive vice president responsible for the Industrial Components and Equipment business. In 1992, Berges took a special assignment as Emerson's "Profit Czar," charged with revitalizing and formalizing Emerson's five-year profit planning process. In 1997, he was named vice chairman and was elected to the board of directors. In 1999, Berges was appointed president. He was elected to the board of directors of PPG Industries in 2000, and to the board of MKS Instruments in 2002. He serves as chairman of the board of commissioners for the St. Louis Science Center, as vice chairman of the National Association of Manufacturers, and as a director of the U.S. Chamber of Commerce. He is a member of the Business Advisory Council at the University of Notre Dame College of Business, and is a Trustee of St. Louis Children's Hospital. He was recently appointed to the Guangdong Governor's Economic Advisory Council. He also received a presidential appointment to the Advisory Committee for Trade Policy and Negotiations in 2005. Since writing this essay, Berges has retired from the company.

IT IS NOT JUST LEADING-EDGE TECHNOLOGY that sets our equipment apart. It is our ability to manage information to help customers optimize their investments.

**John Cataldo**

GENERAL MANAGER, MARKETING AND COMMERCIAL OPERATIONS, OPTIMIZATION AND CONTROL, GE ENERGY, UNITED STATES

**Bernie Anger**

GENERAL MANAGER, TECHNOLOGY, OPTIMIZATION AND CONTROL, GE ENERGY, UNITED STATES

# Driving innovation to power the world

## GE Energy Profile

GE ENERGY IS PART OF GE INFRASTRUCTURE, one of the world's leading providers of fundamental technologies to developed and developing countries. The Infrastructure portfolio includes technologies and services for aircraft engines, energy, oil and gas, rail, and water processing. As one of the world's leading suppliers of technology, products, and services to the energy industry, GE Energy had 2005 revenues approaching US$17 billion. Services account for approximately 60 percent of GE Energy's revenues and are growing at an average annual rate of 14 percent. That growth stems from several new areas of emphasis and technology development including plant optimization (monitoring and controls), emissions control, and network reliability.

Because the company provides a comprehensive range of solutions across the energy value chain—from supply and conversion to delivery, utilization, and services—it is uniquely prepared to help fulfill demand for reliable, cleaner, and more efficient energy. Through a continued emphasis on research and technical innovation, GE is committed to remaining the industry's premier provider of gas turbine and combined-cycle power generation technology, aero-derivative gas turbine technology, and knowledge-based services.

## Business Environment

EVEN BY THE HIGHLY COMPETITIVE STANDARDS of the manufacturing sector, GE Energy operates in what can only be described as a tough market. Considerable consolidation of the customers it serves has taken place since the late 1990s, and as the market has matured, margins have come under increasing pressure. Power generators, for example, tend to talk in

terms of delivering their customers a nickel more every day. In a sector where a quarter of a percent of heat rate can significantly impact a generator's bottom line, pennies and nickels really do make the difference.

The cynical nature of the business is one fundamental challenge we face. Demand varies significantly depending on where customers are in their business development cycle. One year the priority may be to secure additional power-generation capacity, while the next it may shift from capacity growth to maximizing efficiencies with existing equipment. In the United States, the emphasis is on finding more capacity in the existing base of installed assets. Similarly, at a macro level, the sector is subject to global shifts in demand. Today, demand for gas turbines is growing in most of Asia and in parts of Europe. In North America, the Canadian market is growing also. The United States, however, has been suffering from significant overcapacity of turbines during the last few years, and this, by itself, has reduced the overall global market. From a worldwide perspective, there has been a significant build-up of gas turbine equipment since about 2001.

**GE Energy operates in what can only be described as a tough market.**

Inevitably, this overcapacity has put downward pressure on prices, forcing suppliers—including GE Energy—to reappraise their cost structures continually. The company has responded by looking to emerging markets for product supply, driving hard over the last five to six years to find suitable partners in eastern Europe, and particularly in China. Gas turbines, of course, are significant assets, and their complexity means that GE has had to develop a new infrastructure to work effectively with these offshore partners. Not only do sufficient quality controls need to be in place during the component sourcing and manufacturing stages; comprehensive documentation and tracking systems are also needed to guarantee the authenticity of parts.

These requirements are not limited to the initial product-sourcing stage. It is equally important that information flows freely between GE and our suppliers throughout the lifecycle of each product. This allows refinement of ongoing maintenance techniques and the ability to feed data back into the manufacturing cycle, enabling continued product improvement.





Balancing these competing demands for cost control and continual improvement in product quality is fundamental to meeting corporate objectives. Two key factors enable us to accomplish this: customer intimacy and innovation.

### Customer intimacy

As with other manufacturing sectors, the energy industry has recently moved from a transactional perspective, where the focus is on securing a series of sales, to a contractual one, where sales are seen in the context of an ongoing contractual relationship. Today, a high percentage of GE's customers for power-generation machinery are on contractual service agreements. In fact, these contracts constitute a portfolio of close to US$30 billion in contractual commitments, where the performance of a customer's power plant(s) is guaranteed through service-level agreements. Investing in technology helps us meet those contractual obligations at multiple levels.

First, GE continues to invest heavily in primary technologies, such as materials and thermodynamics, as well as in simulation and modeling capabilities. These technologies are leading edge, from a design perspective. It is a precision skill, for example, to be able to burn fuel at the highest possible temperature without damaging the machine's components.

We also deploy computer control systems that allow us to run our equipment as close as possible to its physical limits. The nearer you are to achieving peak performance, the better you are able to create fuel efficiency, gain tighter control over emissions, and so forth. The equipment is supported by our remote diagnostic capability and collaborative technologies that connect customers to our experts. We can help customers diagnose equipment problems on a special basis or provide continuous remote monitoring.

Just as important, we collate all of the operational data from assets such as turbines, compressors, and generators. This information is aggregated and analyzed using proprietary algorithms to improve our understanding of optimal equipment performance. We recognize that customers have different priorities. For instance, one customer may have an emissions-driven strategy, while another may focus on energy output. Thus, we need to understand how different assets perform within an industry and under different operating conditions. We then pass this analytical information back to our customers. By doing so, we help customers replicate best practices that may have developed on another side of the world.

GE Energy's optimization and control business value proposition is based on this unique domain knowledge—a deep understanding of the operating characteristics of each asset, the applications that run on them, and the impact each has on the other. We work closely with our customers to build and share this expertise, trading knowledge across the industry with operating and maintenance managers. We also conduct tailored analyses to predict potential problems, looking at asset histories and the frequency and criticality of particular failure modes, and then assess the potential impact on a customer's business.

The more we accumulate performance information and analyze it, the more we can hone in on those small but significant changes that contribute to sustained increases in customer profitability. So, not only are we guaranteeing performance against predefined goals, we are constantly looking to improve the profitability of all of our assets to benefit our customers.

**We are constantly seeking ways to differentiate ourselves further to fuel margin growth.**

This depth of understanding can result in savings of millions of dollars. If we accurately predict when a critical piece of equipment will need to be serviced, we can avoid surprise failures. Unplanned stoppages in downstream activities, such as petrochemical refineries, have a significant financial impact, leading to lost production and large overtime payments. By contrast, if you anticipate and plan for downtime, you can deploy alternative assets to provide coverage, or schedule outages for slower periods. The same is true for preventive maintenance in power generation. Typically, a repair can cost many millions of dollars, so knowing in advance that an asset needs to be shut down can prevent expensive repairs down the road.

As part of these contractual service agreements, the economic benefit of performance increases we provide to customers also are shared with GE. In some parts of the world, particularly in emerging markets, customers are reluctant to pay for services. In the United States and western Europe, however, customers recognize the value that these services provide, and we can charge for them as long as we demonstrate we are supplying unique domain knowledge and expertise.

GE has a reputation for focusing on quarter-to-quarter growth, and its business leaders—from sales and marketing to technology—are





expected to contribute to meeting growth targets. As a result, while our contractual commitments provide some revenue stability, it is not enough for us simply to ride on the backs of those agreements. We are constantly seeking ways to differentiate ourselves further to fuel margin growth. For example, our GE Energy business has a widely distributed workforce, with engineers in China, India, Hungary, and elsewhere around the world. We have invested heavily in collaborative development techniques and tools, as well as in sophisticated communications infrastructure, to allow these dispersed groups to work together virtually.

### Harnessing innovation

Besides customer intimacy, we also rely heavily on innovation to fuel profitable growth. Innovation manifests itself in many different ways. It is not only about creating and sourcing new products and add-ons; it also involves refining our methodologies and replicating best practices. Innovation is not restricted to a particular function; rather, it must permeate the organization.

Whether they are making initial purchases or upgrading existing equipment, our customers look to us for product leadership in one or more of four key areas:

- Heat rate (which equates to efficiency)
- Output
- Emissions
- Reliability or availability

We meet these needs through a novel approach to research and development (R&D) that takes advantage of the resources available across GE. Unlike many other organizations, we tier our technology investments. Our lines of business work on their specific development needs, driven by business objectives. We also have a groupwide research center that focuses on extremely long-term projects, such as new material inventions. Because of this, our core groundbreaking technologies can be applied across multiple lines of business. For example, if GE invents a new material, it also can be used by our energy, home security, and healthcare operations.

We couple this internal R&D effort with a keen focus on what is happening elsewhere in the energy community, analyzing what we call "destroy-the-business" issues that may come from outside our partner network. This approach is applied to every aspect of the business, not only to manufacturing. Our philosophy is that if there is a groundbreaking innovation out there, we should embrace it to challenge our own competitors. We focus on imagination breakthroughs—US$100 million-plus ideas that can truly push GE forward and that have high visibility from our chairman down through the ranks.

By harnessing innovation in this way and by achieving customer intimacy, our GE Energy business will be able to sustain and grow its position, achieving our business goals despite the challenging market conditions we face. To do so, we will continue to rely heavily on technology—from computer control systems to information collation, analysis, and distribution.

After all, it is not just leading-edge technology that sets our equipment apart. It is our ability to manage information to help customers optimize their investments.

**JOHN CATALDO**

GENERAL MANAGER, MARKETING AND COMMERCIAL OPERATIONS, OPTIMIZATION AND CONTROL, GE ENERGY, UNITED STATES

In his current role, John Cataldo leads a global team in strategy development, marketing operations, and sales and customer support for one of GE Energy's new growth platforms in sensors, electronics, and software tools for energy industry-asset optimization. With 10 years of experience at GE, Cataldo previously led the Business Development group, focusing on mergers and acquisitions for GE Energy Services—the US$7 billion U.S. Services business of GE Energy. He has also served in Six Sigma leadership roles within GE Energy, and in GE's Corporate Business Development group. Prior to joining GE, Cataldo was a consultant with McKinsey & Co., in Atlanta. Before that he was the executive officer to the U.S. Air Force Academy Dean of Faculty, and a U.S. Air Force pilot. Cataldo has a bachelor of science degree in civil engineering as a Distinguished Graduate of the U.S. Air Force Academy, and a master's degree in business administration as a Baker Scholar of the Harvard Business School.





**BERNIE ANGER**

GENERAL MANAGER, TECHNOLOGY, OPTIMIZATION AND CONTROL, GE ENERGY, UNITED STATES

Bernie Anger is general manager, technology, for GE Optimization and Control, one of GE Energy's new growth platforms in sensors, electronics, and software tools for energy industry-asset optimization.

Serving GE since 1999, Anger has more than 15 years of experience defining and implementing world-class solutions for optimization and controls. In his current role, he is responsible for establishing the company's technology roadmap, as well as new product development and solution engineering. Anger held several roles prior to joining GE Energy, including vice president, software technology for GE Fanuc; chief technology officer for Total Control Products; and vice president of development for Taylor Industrial Software.

DIGITAL SERVICES is one way to apply today's technology to propel healthcare into the future.

**Paul Mullen**
GLOBAL PROGRAM MANAGER, DIGITAL SERVICES, GE HEALTHCARE, UNITED STATES

# Digital Services for healthcare: technology that enables the human touch

**HEALTHCARE PROVIDERS TODAY FACE CONSTANT PRESSURE to improve efficiency and increase the quality of care. As one step toward higher productivity, they turn to technical improvements in devices they use to diagnose and monitor disease. They also work their equipment harder, with longer hours and fuller schedules. It's unthinkable for a device to be out of service when a patient needs it.**

TO ADDRESS THESE CHALLENGES, healthcare equipment manufacturers constantly search for ways to reduce device downtime and help caregivers manage assets effectively. GE Healthcare has found answers in the digital world. GE Healthcare CEO Joe Hogan has stated, "To take healthcare into the future, we don't have to wait for technologies that will be available in 2025. We need only look at the technologies we have today, and act."

That approach is at work in a model called Digital Services, which has begun to revolutionize the way hospitals and clinics maintain and repair their critical equipment. The traditional model of service relies on field engineers traveling from site to site, making diagnoses, ordering replacement parts, and completing repairs. Under the Digital Services model, online engineers check and monitor equipment from afar, on secure broadband connections. Often, these engineers can fix problems remotely, so that a field engineer does not have to visit the site. Furthermore, they can detect warning signs of trouble in a device and dispatch a field engineer to fix it before the device fails and without the end user knowing anything was wrong. As one result, highly educated field engineers are freed from the tyranny of responding to the latest emergency. Instead, they can focus attention on the most critical issues, working with care providers on proactive and highly effective device maintenance and service programs.

At the same time, Digital Services reaches beyond service and repair. It encompasses capabilities from online software upgrades to operator training delivered by distance learning over secure broadband connections. In short, Digital Services changes the service relationship between healthcare provider and supplier. Providers benefit from:

- Shorter repair times and more equipment uptime
- Lower overall ownership costs
- Prevention of unplanned downtime
- Assurance of high-quality images from sophisticated scanning devices
- Full use of device capabilities

End-user benefits aside, Digital Services strengthens GE's offerings in two key ways. First, the collection of service and repair data enables creation of a global repair database that helps service personnel diagnose problems and make repairs faster. GE has developed a digital knowledge database that learns as it is used, improving the diagnosis with each recorded event. That means the company can deliver higher-quality service while freeing service people to give care providers more personal attention. Second, Digital Services data provides critical field information about device operation and quality—information GE's design and manufacturing organizations can use in a continuing quest to build better products.

### Transforming care

Headquartered in the United Kingdom, GE Healthcare is a US$15 billion unit of General Electric Company, employing more than 45,000 people worldwide and serving healthcare professionals and patients in more than 100 countries.

With expertise in medical imaging and information technologies, medical diagnostics, patient monitoring, performance improvement, drug discovery, and biopharmaceutical manufacturing technologies, the business helps clinicians find new ways to predict, diagnose, and treat disease, so that patients can live their lives to the fullest. GE offerings enable caregivers to diagnose and treat cancer, heart disease, neurological diseases, and other conditions earlier. The vision for the future is an "early health" model of care that focuses on earlier diagnosis and disease prevention.





GE Healthcare develops diagnostic instruments such as X-ray machines, magnetic resonance imaging (MRI) and computed tomography (CT) scanners, and patient monitoring devices. The company also provides information technologies that help clinicians collect, store, and access data about patients quickly and easily, in the form of electronic medical records. The Life Sciences section of the business delivers breakthroughs in drug discovery, biopharmaceutical manufacturing, and the latest in cellular technologies, so that scientists and specialists around the world can discover new ways to predict, diagnose, and treat disease earlier. The Life Sciences unit also makes systems and equipment for purifying biopharmaceuticals.

### A new approach to service

When it comes to Digital Services, GE uses technology to multiply the expertise of some 4,000 service engineers. To date, it has improved product maintenance, optimized device performance, increased the productivity of service engineers and, most important, enhanced the quality of service to healthcare providers.

**Scientists and specialists around the world can discover new ways to predict, diagnose, and treat disease earlier.**

GE Healthcare was first in its industry to apply remote digital technologies to service and remains the clear leader in the field. Digital Services began in 1989 with the introduction of InSite remote diagnostics. At first the technology was used to monitor the superconducting magnets in MRI scanners. The system monitors the level of liquid helium that keeps the magnet at the cryogenic temperature (around 3 degrees above absolute zero) necessary for proper functioning. Next came the ability to deliver basic software modifications, and eventually full software upgrades, to healthcare providers online. Over the years, the company has steadily extended remote capability across its product line, both to monitor individual systems for end users' benefit and to generate intelligence on trends. Today, more than 44,000 medical devices are connected to Digital Services. Service volume exceeds 11 million transactions per year, far more than for any other healthcare device producer.

At the most basic level, Digital Services helps healthcare providers get quick solutions to device problems without having to wait for a field engineer. In a typical scenario, the device user calls the service center and describes the problem to an online engineer. The engineer makes a diagnosis, and if possible—as in the case of a software fault—carries out the repair online, saving the user the inconvenience of waiting for an on-site service call. If the online engineer cannot complete the fix—as in cases where a component has failed—a field engineer is dispatched. Significantly, because the diagnosis has been made remotely, the field engineer arrives on-site fully prepared to make a quick repair and equipped with all necessary tools and spare parts.

**In service, repair, or training, the key to Digital Services is to understand that technology alone is not enough.**

At a level more consistent with the concept of "early health" lies a capability called Proactive Digital Services, provided with sophisticated X-ray systems used to diagnose heart disease. These systems, brand-named Innova, demand a higher degree of care because a failure during a procedure could put a patient at risk. Proactive Digital Services does not wait until the device user notices symptoms and calls for service. Instead, GE's automated systems monitor the devices remotely and watch for operating anomalies that signal impending malfunction or failure. These systems can automatically dispatch a field-based or remote engineer to take action.

The advantages of proactive service have been well-documented. GE pilot-tested the concept in 2004-05 on advanced CT scanners in place at multiple hospitals. During the pilot, end-user downtime was reduced by about 20 percent, and half of the remaining downtime was shifted from unplanned to planned. Caregivers thus received more assurance of having scanners available to patients needing exams.

### Building the knowledge bank

Besides improving repair productivity, Digital Services provides data that can be used to assess the long-term performance of equipment models and to make predictive recommendations. As with the diagnostic tools, the more data is collected, the more the knowledge





infrastructure learns, and the more accurate GE decision support becomes. For example, if engineers can use the data to determine the average lifespan of a device, they can advise care providers who own that device when to start planning and budgeting for a replacement. Over time, as service data is collected about a specific model, engineers can examine the performance of an individual device, infer from the data how the device is being used, and advise hospital personnel on ways to adjust usage to improve performance.

Digital Services has delivered tangible results for healthcare providers and GE Healthcare. When a repair is moved from on-site to remote, repair time falls from four hours on average to 45 minutes. In early Digital Services experience, device downtime has dropped 40 percent based on average experience from 50 systems, and repair costs have shrunk considerably.

### Digital education

Outside the service arena, a growing application of Digital Services is in training hospital staff members who use sophisticated diagnostic scanners. The better clinicians are trained on these systems, the greater the benefit to patients and the higher the hospital's return on investment.

In today's cost-constrained environment, many hospitals cannot justify in-person training at their site or at a manufacturer's training center. For these providers, virtual assist training by distance learning is a practical alternative. In this scenario, technologists train in their own facility, using their own equipment. They interact with a GE instructor at a remote site through a high-speed broadband Internet connection. The instructor and technologists see the same screen. Technologists watch as the instructor demonstrates complex procedures. Then the instructor observes and critiques as the trainees practice what they learn. Because instructor and trainees share control of the system, the training is as effective as if the instructor were in the room. Virtual assist training is growing rapidly: healthcare providers see it as an affordable way to learn and keep up with fast-evolving diagnostic technologies.

### Protecting partnerships

In service, repair, or training, the key to Digital Services is to understand that technology alone is not enough. The organization's culture must change to deploy the technology to maximum benefit. The temptation is to think of Digital Services simply as a way to drive out

cost by reducing labor and cutting staff. Such thinking ignores the reality that quality service in healthcare is built on close partnerships between service provider and clinician. That feature of the relationship does not change simply because more business is transacted digitally.

The GE Healthcare service network uses Digital Services in large part to enable field engineers to spend less time replacing bulbs and turning wrenches and more time building mutually beneficial, proactive, strategic service relationships with healthcare providers. Even online engineers in remote service centers are locally assigned: device users who call have reasonable assurance of talking consistently to the same people, who understand their equipment and their unique challenges.

Digital Services also depends on secure connections: communicating with devices while protecting the integrity of the healthcare provider's information. Hospitals are justly concerned about empowering a partner to reach into the hospitals' networks; they have both network security and patient privacy concerns to manage. GE addresses the concern with an approach unique to healthcare, in which all communication between the devices and GE is outbound, and always by way of a secure sockets layer connection. In this configuration, care providers can receive Digital Services without modifying their firewalls or specially coordinated VPN connections. The connections operate freely, while business, financial, marketing, and, above all, patient information remains secure.

Digital Services is steadily moving healthcare device service from reactive to proactive, and has promise to help manufacturers enhance fleet lifecycle management, improve product design, and increase care providers' productivity and quality. GE continues to explore and deploy new generations of digital monitoring, data management, and repair techniques. Digital Services is one way to apply today's technology to propel healthcare into the future.

**PAUL MULLEN**

GLOBAL PROGRAM MANAGER, DIGITAL SERVICES, GE HEALTHCARE, UNITED STATES

Paul Mullen leads GE Healthcare's Digital Services programs. A 23-year veteran of healthcare engineering, marketing, and business development, Paul is the author of six U.S. patents in healthcare-related technologies. He is active in local schools, leading statistical analysis of factors related to student achievement, and he serves on the board of directors of charitable organizations in the United States and Guatemala.

Connective Manufacturing is as much about connecting design and development between company and customer as it is about establishing importance within the company itself.

**Dieter May**
SENIOR VICE PRESIDENT, CORPORATE STRATEGY, INFINEON TECHNOLOGIES AG, GERMANY

**Christian Suttner**
VICE PRESIDENT, EMERGING BUSINESS, INFINEON TECHNOLOGIES AG, GERMANY

# The promise of RFID in the manufacturing value chain: "Eating your own dog food"

**Dieter May and Christian Suttner of Infineon Technologies discuss Infineon's philosophy of mass customisation, and look at how connected manufacturing involving the customer is essential for the future.**

## About Infineon

Infineon is a leading innovator in the international semiconductor industry. We design, develop, manufacture, and market a broad range of semiconductors and complete system solutions targeted at a range of different industry sectors. Our products serve applications in the wireless and wireline communications, automotive, industrial, computer, security and chip card markets. Our product portfolio comprises both memory and logic products, and includes digital, mixed-signal and analogue integrated circuits, as well as discrete semiconductor products and system solutions.

Infineon's current revenue is €7.2 billion, or US$9.5 billion. In the first three quarters of 2004, we were the fourth largest semiconductor player, according to Gartner, a market research firm. Previously, we were number five, so we have made significant inroads over the last three years. We have approximately 35,000 employees and are becoming a truly global business.

Established in Bavaria, Germany, we now have manufacturing sites on three continents, and research and development facilities (R&D) worldwide. We are upscaling our resources significantly in Southeast Asia. Also, from a revenue perspective, we now enjoy the greatest growth in Asia—specifically in China. Because our revenue split is changing, we are adjusting our resources accordingly, especially in R&D. We have significantly increased our software- and hardware-development resources in Asia using a design factory concept in Xian, China, where we

have about 1,000 designers. Similarly, we have heavily ramped up our software competence centre in Bangalore, India.

We are bringing R&D resources closer to our customers, which aligns with our philosophy of mass customisation. You can have conceptual development and architectural development wherever, but it is mass customisation that brings you closer to the customer.

### Connected manufacturing impact for Infineon

Connected manufacturing is about connecting design and development both within the manufacturing business and, increasingly, between manufacturer and customer. Being connected is, therefore, central to our future goals, both for our own business and for the businesses with which we work—our suppliers and clients. Achieving transparency across the supply chain is a priority, and we are increasingly introducing radio frequency identification (RFID) technology to achieve this.

Central governance, however, is critical for the successful implementation of new technologies, and we are making significant inroads—both in terms of testing ways to make the business more connected, and in implementing new technologies companywide.

**Visibility across the market chain**

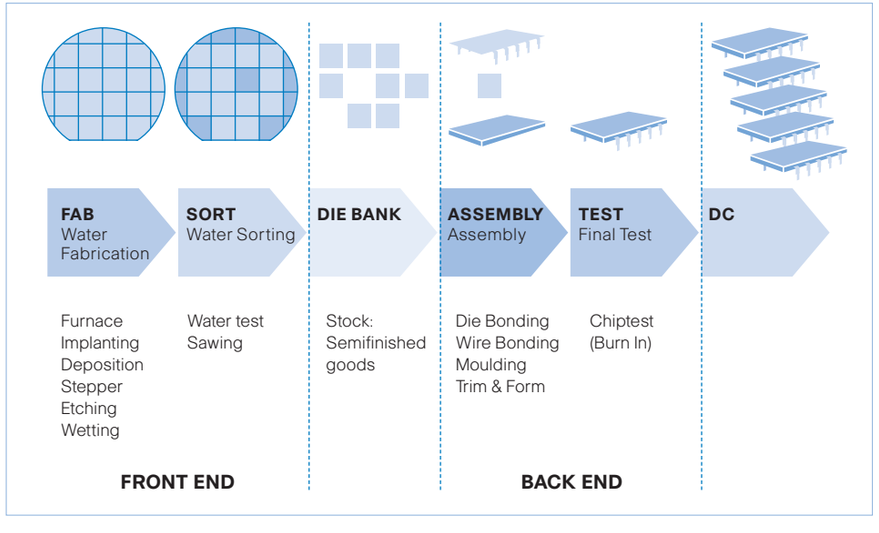



Figure 1 Infineon Technologies, used with permission.





### From product manufacturing to solution manufacturing

A significant trend we are currently experiencing is the shift from a few products to complete solutions; in other words, products enhanced by software—which is more and more a value driver for our business—as well as services. Ten years ago, everyone was selling individual components which a third party would assemble into a final product. Today, it is increasingly a project business dependent upon collaboration with our customers.

**From product to solution manufacturing**

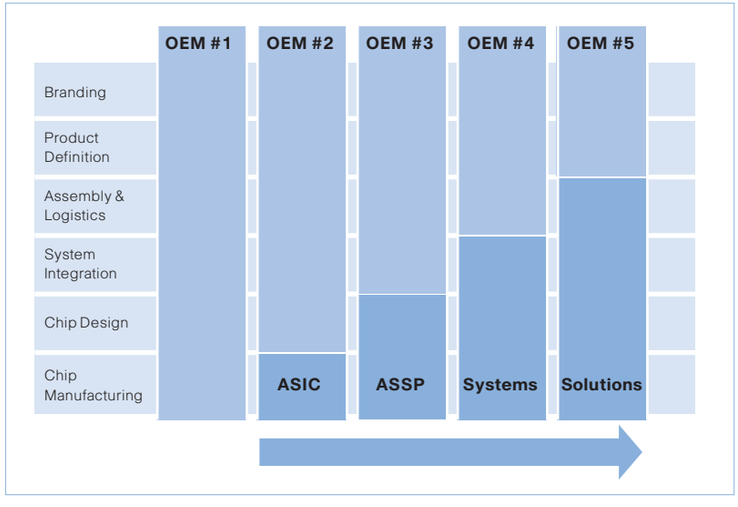



Figure 2 Infineon Technologies, used with permission.

Take mobile phones, for example. We are able to design and build complete handsets for different platforms, such as Universal Mobile Telecommunications System (UMTS) or General Packet Radio Service (GPRS). Building complete units is a new market requirement, so it is no longer sufficient to sell just standalone components; you need to provide a total platform including certification and software platform specifications, and so on. This is a fundamental change to our business model.

Typically, we work with first-tier players in the market on platforms, so we have a lead customer—one of our biggest is Siemens Mobile. Together we are developing platforms that we then market as a complete solution to second-tier customers who do not have the

design resources to develop these platforms from scratch themselves. Time to market is obviously critical, but so, too, is having a highly scaled platform that can easily provide mass customisation, because nowadays not everyone wants to buy similar kits; customisation is expected.

Looking at our corporate strategy, we have implemented many of the things we wanted to do, such as building up software competencies and shifting our R&D landscape. But there is still, we think, a lot of potential to become as profitable as we would like to be. We need to become much more customer-focused—bringing resources much closer to the customer. On the operational side, of course, optimisation of manufacturing plants is a priority; but just as important is R&D execution—one of our key future priorities—where there is still a lot of work for us to do. In terms of our memory business, for example, our clear objective is to catch up with Samsung. Elsewhere, we are looking at outside companies—and other industries beyond the semiconductor sector—where we can work together to satisfy mutual goals. Being connected is key for us to achieve all these business goals.

**A significant trend we are currently experiencing is the shift from a few products to complete solutions.**

Being connected means greater visibility, and our ultimate goal is transparency throughout the production process. It is important for us to optimise our internal setup so that we are sure we are running our manufacturing plants with the best optimisation. But a significant challenge for us is industry cycles. How to behave within these cycles is critical because there are huge investments to be made, and they must be made at the right moment in the cycle or else it can be very dangerous for the company.

### Limited supply-chain visibility in the past

Just before Christmas 2000, one of our biggest customers on the mobile phone side told us they needed five million more mobile phone base chips. Then, two weeks after Christmas, the customer suddenly cancelled seven million. There was no visibility throughout the supply chain. So we tried to build up much more transparency across the industry segments we serve; this started an initiative to get much closer to the end consumer. We are not in the consumer business, and





normally we have no direct linkage to the end customer. But we wanted to change the strategy of our marketing to include the end customer. The mobile phone business provides a clear illustration of why this is important for a business such as ours.

Everybody believed there would be an additional 30 per cent growth in mobile phone sales in 2001, and that this would go on forever. But all you needed to do was to look at population sizes and penetration levels to see that this was unsustainable. You have to be much more focused toward the end customer and be able to challenge what your direct customer tells you.

**Closed loop between factory and sales planning**

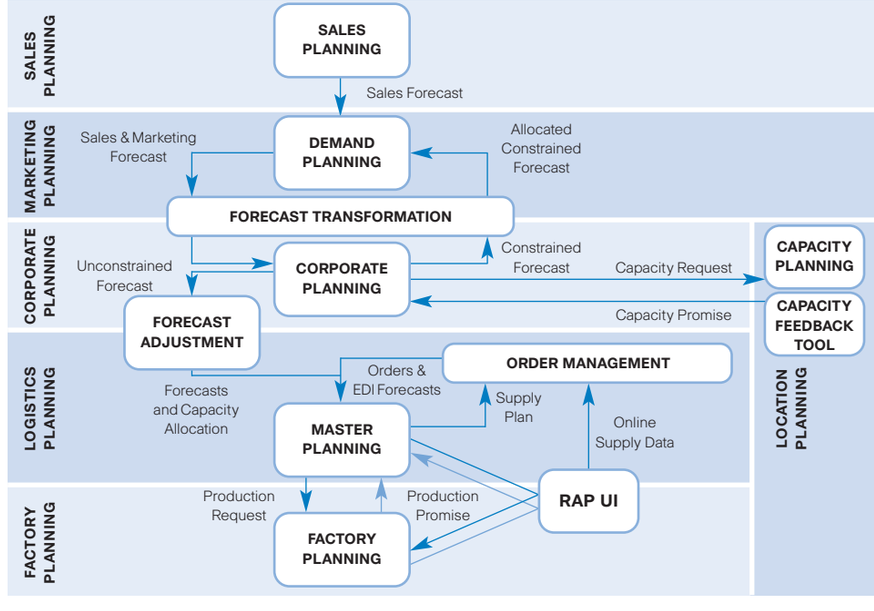



Figure 3 Infineon Technologies, used with permission.

### Improving visibility and business intelligence

Now, we strive to have good visibility about supply-chain data. For example, in the mobile phone industry, we try to understand where the trends are going rather than relying solely on what the people at our customers are saying. So we look at the distributors and retail outlets,

and beyond, to draw our own conclusions. We now do this for all of our industry segments to generate much better planning throughout.

The second thing we have been doing is developing a scenario model and an early-warning indicator system that allow us to forecast turning points and the strength of an upturn or downturn eight months ahead. Such indicators give us time to think earlier about the decisions we need to make. In February 2004, we had discussions about an expected dip affecting the market, and we were able to put what we call a "smart savings programme" in place before the downturn worsened to avoid layoffs and so on. Using the information smartly, however, is what really counts. So it is not so much about the system as the system process.

We are also working hard to generate transparency throughout our own manufacturing process, and RFID is playing an important role here. Previously we relied on bar codes. RFID is automated, however, and reduces the danger of human error. Our wafer boxes now contain RFID, so that we always know where they are, and what they need. There is direct communication and, of course, no more handwritten data. RFID is an important area for us. We produce the RFID tags but not the RFID readers.

Ideally, we will connect the whole supply chain to RFID—from wafer delivery through our basic manufacturing plants processing the wafers, to the back end and on to the customer. In this way we will be able to track and trace everything we need. And with every part labelled, if there is a problem with a particular one, other components that might be affected are far easier to trace.

Naturally, helping to ensure that RFID labels can be accurately read is critical. Yet companies trip up. This is because 100 per cent efficiency in RFID reading is not just about where you position the RFID tags. You must have the most appropriate scanning device for the job, and you must closely monitor the efficiency of RFID measurement. While a bar code is a bar code—each is always the same: a set of black and white stripes—RFID is different. You can use different antennas, and if you have an extremely difficult environment when tuning tolerance levels, you may only be allowed to use a lower tolerance. Every chip and every antenna has some tolerance built in, so you may only be able to use higher-quality products. If you are failing to read, say, 10 per cent of the RFID-tagged parts, then you must understand exactly why; is this because of tolerance of components, the reader not being strong enough, or something else? Maybe you need a stronger





electromagnetic field or to shield the environment to prevent disturbance from other electromagnetic fields. You cannot just think "This is another bar-code-like system and I'll just put the reader here." You have to evaluate the system and be prepared to tweak and tune the entire setup consisting of chips, antennas and readers (again, with options for different electronics and antennas). Today, the shortcoming with RFID is not the technology itself, but finding enough people able to implement it properly.

**Being connected is, therefore, central to our future goals, both for our own business and for the businesses with which we work—our suppliers and our clients.**

### "Eating our own dog food"

One of our internal RFID-related projects has connected the back end with our distribution centre, and we are now measuring what the improvements are. The aim is to learn in year one before rolling out RFID companywide thereafter. Because of the introduction of RFID, we discovered that some of the processes we assumed were in place were actually ineffective, leading to reduced data quality in our warehouse system. Through RFID, we detected these ineffective processes and were able to rectify them. This example highlights the importance of RFID for outsourcing and other partner-integrated processes; the challenge is to create visibility in systems you do not directly control. RFID enables you to do so because it is automated—there is no way to fiddle with it.

We were quick to set up a corporate framework for RFID comprising five core processes, with an integrated supply-chain management process that has been completely redesigned over the last year to allow for new tools and systems such as RFID. Because our supply-chain process was focused on components, we were unable to do a number of things previously, such as add a consulting fee into our system (because it had no product part number). Now we can do that, along with platform pricing for our customers and selling added value for our overall platform solution. Today we know exactly where the interfaces are, how the processes are working, and how any new processes developed within the business are interconnected. If we

introduce new technologies that result in major changes to a process, we immediately see the impact on other processes.

Obviously, there must be a business case behind all this, as the investment in RFID must be justified. Our estimate is that we are currently saving thousands of euros, because the value is very high on very small items within our supply chain; and this is the nature of the business in which we operate. But RFID is not just about financial value; RFID is also about time. In this industry, time is of the essence as our goods decrease in value so quickly. Store a dynamic random access memory (DRAM) chip one month longer than necessary and the financial value of that chip decreases.

A key component for efficient installation and operation of an RFID hardware infrastructure is middleware software that provides RFID reader management and supply-chain management/enterprise resource planning (SCM/ERP) system connectivity (or connects to the next middleware layer). Since no appropriate software was available on the market, we built our own. We also developed a "tube approach," where we preconfigured and tuned all RFID hardware components to suit particular environments and applications, which makes new installations a lot faster and more cost-effective. Given our lead experience and the widespread demand from companies introducing RFID, we offer RFID to the market through our RFID SCM solution business, where we help customers to set up RFID based on our RFID hardware and software expertise and operational experience. In fact, we built a partnership with SAP offering end-to-end RFID solutions, which we believe constitutes a real market breakthrough.

**The investment in RFID must be justified. Our estimate is that we are currently saving thousands of euros because the value is very high on very small items within our supply chain.**

Components remain our core business, of course—if you want to be a solutions provider, then you must dominate at least one element of the value chain in which you operate. But software and services are an add-on—if we can make money out of it, then so much the better.

The new, centralised process frameworks we have introduced over the last year are part of a move away from the traditional focus on supply chain in favour of viewing the production process as "idea to





product." This has been a transition we have been working toward for the past five years. Managing and implementing this comes down to central governance. We have process owners within the business to deliver this—typically, first-level managers.

For example, the head of logistics is the owner of the demand-to-stock process. The head of strategy is responsible for the vision-to-plan process. Central governance has been a major change, and to implement it we needed total trust in data coming from the production process, which is critical to achieve truly connective manufacturing.

### Innovative enabling technologies

Today there is a lot of attention on RFID, which is a short-range technology. Looking further ahead, we are considering how Bluetooth, wireless local area network (WLAN) and Zigbee will develop. Wideband will have far-reaching implications on wireless standards, and will typically be business driven. For example (aside from Bluetooth), the competence for short-range wireless has moved to our wireline business where we basically need a home gateway—not only a faster Ethernet gateway, but one that encompasses all of the wireless standards. We are watching these technologies closely—especially from the perspective of our mobile phone business, since two years from now it will probably be desirable to combine a WLAN and a normal GPRS transceiver into a single chip. The question will be: Does it work from a power consumption point of view? Two of our business groups are pursuing this, and a third is looking at the wireless conductivity perspective.

Being connected, however, is also about using new technologies for working collaboratively. Internally we have wireless LAN access in our main building, and will have the same in our new headquarters (currently being built to house 7,000 staff in an open campus). Access to these buildings is via smart cards, and, again, we will use our own technology. We are an increasingly global business, so helping to ensure that workers around the world can collaborate and benefit from new technologies for their own personal development is key. Global connectivity is especially important on the design side of the business so that our designers can access our IP database anytime, from wherever they choose. It is a real-time network, and it is global.

Looking to the future, our global network could well be used for mass customisation. The time may come when end users detail their own personal requirements for true, individual personalisation of

products. Already you can log onto the Nike Website and design your own shoes. Mass customisation for us is slightly different: it is about having a platform approach with which you can serve a small number of customers with minor adjustments. And it will be in the negotiation phase that customer specifications are discussed and agreed upon, rather than at the point of sale.

**The time may come when end users detail their own personal requirements for true, individual personalisation of products.**

Customization is in line with our vision of a future in which collaboration between ourselves and our customers becomes the norm. The relationship will increasingly become an implicit joint venture because each party is so closely interlinked: the customer is, essentially, dependent on us and we, of course, depend on our customer.

### Summary

Connective manufacturing, then, is as much about connecting design and development between company and customer as it is about establishing the importance within the company itself. It is essential to control both design and manufacturing, because you need to know in the design phase exactly how well your production process is behaving, especially in more complex products, such as base chips for mobile phones. This detailed degree of understanding will be an increasingly important differentiator between competing manufacturers in the years to come.

**DIETER MAY**

SENIOR VICE PRESIDENT, CORPORATE STRATEGY, INFINEON TECHNOLOGIES AG, GERMANY

Dieter May joined Infineon Technologies AG in 2000 as vice president, corporate strategy, and in 2003 was named senior vice president, corporate strategy. After receiving his master's degree in microelectronics at the University of Erlangen-Nuremberg in 1990, he joined IBM in Bordeaux, France, as a project leader for applied research in failure analysis for integrated circuits. In 1992, he joined Motorola, Inc., Munich, as European marketing manager, Logic IC Division. In 1997, he was promoted to global telecommunications market manager, Standard Components Group, in Munich and Phoenix, Arizona. In 1999, he joined Booz Allen Hamilton, Munich, working as a strategy consultant in the field of mobile network operators, wireline infrastructure, and energy companies. In 2005, May was appointed senior vice president, Silicon Discretes in Munich, Germany. Since writing this essay, May has left the company.





**CHRISTIAN SUTTNER**

VICE PRESIDENT, EMERGING BUSINESS, INFINEON TECHNOLOGIES AG, GERMANY

Christian Suttner was named vice president of emerging business at Infineon Technologies AG in 2004. In 2002, he was founder and managing director of Cirrus Management Consulting GmbH (strategy consulting) and Early Capital Partners GmbH & Co. KG (technology investments). In 2000, Suttner was a director at the international investment company Antfactory. In 1996, he was consultant and engagement manager at the international strategy consulting firm Booz Allen Hamilton. Suttner carried out scientific research at the Technische Universität München from 1990 to 1996, and in 1995 wrote his dissertation in computer science. Since writing this essay, Suttner has left the company.

AS THE MARKET LEADER,
our role is to drive the industry into new mobility areas.

**Juha Räisänen**
VICE PRESIDENT AND HEAD OF DELIVERY SOLUTIONS, DEMAND SUPPLY NETWORK DEVELOPMENT, NOKIA CORPORATION, FINLAND

# Producing the right products at the right time: steps toward mass customisation

NOKIA PROVIDES EQUIPMENT, solutions and services for network operators and corporations. The world leader in mobile communications, Nokia drives the growth and sustainability of the broader mobility industry. The company connects people to each other—and to the information that matters to them—with innovative, easy-to-use products. This includes mobile phones and solutions for imaging, games, media, and businesses. In 2004, Nokia posted net sales of €29.3 billion, and its global market share was 32 per cent of the estimated total market of 643 million handsets. This enabled Nokia to continue as the largest mobile device manufacturer in the world. With those figures, and considering the complexity of its products, Nokia is arguably also the leading computer manufacturer in the world. If you take into consideration that camera phones made in 2004 already represent half of the company's volume, then Nokia is also the leading camera manufacturer in the world. With a highly efficient demand-supply network, which in 2004 turned more than 60 billion components into products, Nokia is considered to have logistics expertise comparable to that of Dell or Cisco®.

## Nokia business structure

AS A RESPONSE TO NEW MOBILITY OPPORTUNITIES and increasingly intense competition, Nokia is now organised into four business groups. The first of these groups is infrastructure business networks, while the other three are terminals businesses—mobile phones, enterprise solutions and multimedia (see Figure 1). Horizontal entities, such as the one I manage as part of customer and market operations, serve all business groups.

There are a number of fundamental differences between our infrastructure and terminals businesses. In terminals businesses, the

**Nokia business group structure**

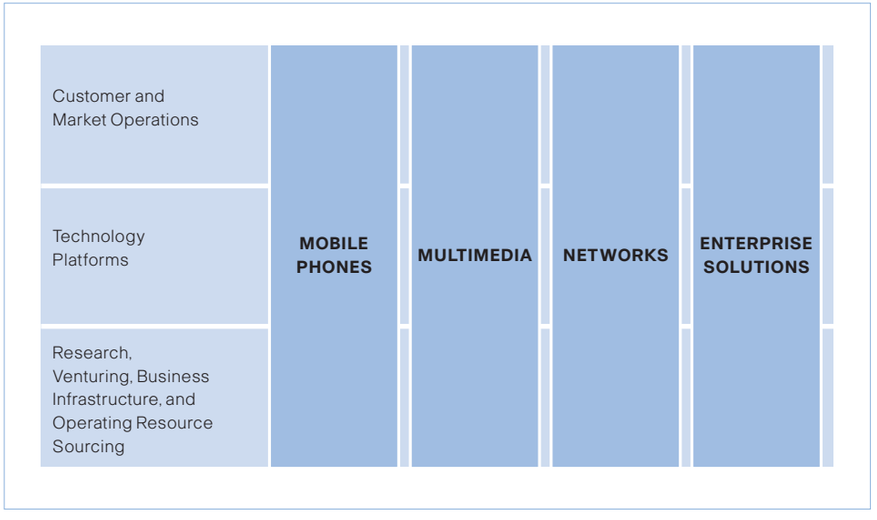



Figure 1 Nokia Corporation, used with permission.

pace is set at the retail point of sale, where "true" consumer demand meets the "true" supply from the channel. Retail business is fast-paced, requiring quick reactions and foresight from the whole supply channel. In contrast, infrastructure business is much slower, with its own, distinct industry dynamics. Across all of our businesses, however, how we manage the demand supply network is critical—specifically, how we collaborate with our partners and how we set up our core processes, systems, and tools.

The new organisational structure helps us drive the mobile communications industry toward something beyond the plain mobile phone. As the market leader, our role is to drive the industry into new mobility areas. Communication and mobility are two basic needs for every human being and, therefore, the potential market is huge. The immense size of these markets means that being first to market is less important than being the first to produce a new cost-efficient concept for the masses. Despite the new drivers for the terminals businesses, the basic principles of how we set up manufacturing and manage the whole demand-supply network remain unchanged. Succeeding in the mobile terminals business is not about moving manufacturing to the cheapest labour-cost countries. Rather, it's about managing the whole demand-supply network most effectively while at the same time being agile and





flexible enough to adapt to fluctuating needs. There is no single, magical solution such as outsourcing, for instance. We see our role as an orchestrator in the value chain, keeping core activities in our own hands and utilising outsourcing opportunities where they make sense from the perspective of an efficient, end-to-end demand-supply network. This strategy is quite different from that of our competitors, and we keep most of the manufacturing in-house.

### Cornerstones for success

Nokia is striving for superior competitiveness in the following three areas: brand, product and operational excellence.

Nokia has become the preferred mobility brand for consumers around the world, in recent years. Strong brand preference creates volume pull from the point of sale toward the channel and, combined with our lucrative product offering and reliable delivery, helps increase market share.

## Creating visibility is the key to fast response and flexibility.

Product innovation and ergonomics have been strengths for Nokia for some time. Innovation here means the ability to include new design elements or product features that add value for customers. From a consumer point of view, "added value" means the new product feature offers sensible uses for the majority of consumers. Some years ago, a manufacturer built a mobile phone into a wristwatch. Nokia did not follow, as there were no obvious benefits from that product concept. On the other hand, there are other numerous examples, such as including a camera in a mobile phone, where Nokia has been the first to introduce a truly useful innovation. Now, half of the volume of phones sold has a camera embedded. Having a pocket camera available all the time has changed the way people can interact: they can capture events or even emotions at any moment and share them instantly with other people.

Operational excellence includes the speed with which an organisation can implement new initiatives, bring new products to market with good quality and deliver orders reliably. During the last decade, it took years to bring a new device to various markets; nowadays we are speaking about months. Concurrent engineering in a cross-functional process mode is key to products getting to market faster.

In the delivery services area, we have achieved good results for our trade customers during the last few years by first ensuring the reliability of our service. Reliability creates predictability, so that our customers can plan their business knowing that Nokia delivers on its promises. The next step is to increase speed of the service. After achieving reliability and predictability, we can introduce new services.

### Visibility requires collaboration

Nokia operates in the middle of the value chain, and there are many companies dependent on us. Much work is still to be done in connecting processes between corporations. Creating visibility is the key to fast response and flexibility. We must understand how the markets behave and what's happening right now in each of them—at the point of sale.

To achieve this degree of understanding, closer collaboration with all of our customers is critical. Collaboration starts with process alignment between the companies. With tens of thousands of different sales package variants, it is also crucial to integrate the systems and provide fast channel information visibility.

Developing customer collaboration is a slow, long-lasting process because it's built on trust—and trust isn't achieved overnight. It requires us to continue building upon several previous mutual successes.

**Communication and mobility are two basic needs for every human being and; therefore, the potential market is huge.**

We can classify our trade customers into three categories: operators, retailers, and distributors. Markets are not alike in various parts of the world. For instance, in the United States, the business is operator-driven, whereas in many Asian markets it's distributor-driven. The roles of operators, retailers, and distributors in the handset supply chain vary slightly from market to market, leading to complex distribution landscapes where no single, global model exists and where every market carries its own characteristics.

Good collaboration with all customers is crucial. The first step is customer-by-customer joint process development. Joint planning processes focus on understanding the point-of-sale channel information visibility and knowledge about which products are selling well, which products are selling below target, why that's happening, and what must





be done to stimulate demand. Gathering and handling sales channel data requires systems and tools, but they are not really the key factor. Using that data sensibly and collaboratively, and making joint decisions based on that data, is what really counts. Channel information availability and accuracy vary from customer to customer, which creates challenges when combining all information to create a reliable market picture.

On the supplier side, we have been able to proceed faster—for years there has been a mutual understanding of the importance of channel information visibility. We provide basic demand visibility to our suppliers on a weekly basis. But we still have a lot to do in integrating suppliers' processes with ours—both in having information on the status of manufacturing with their suppliers, and giving them real-time information regarding developments in Nokia and our markets. Also, as mentioned earlier, the quality of market information still needs more attention.

**The number of connected suppliers is rising steadily**

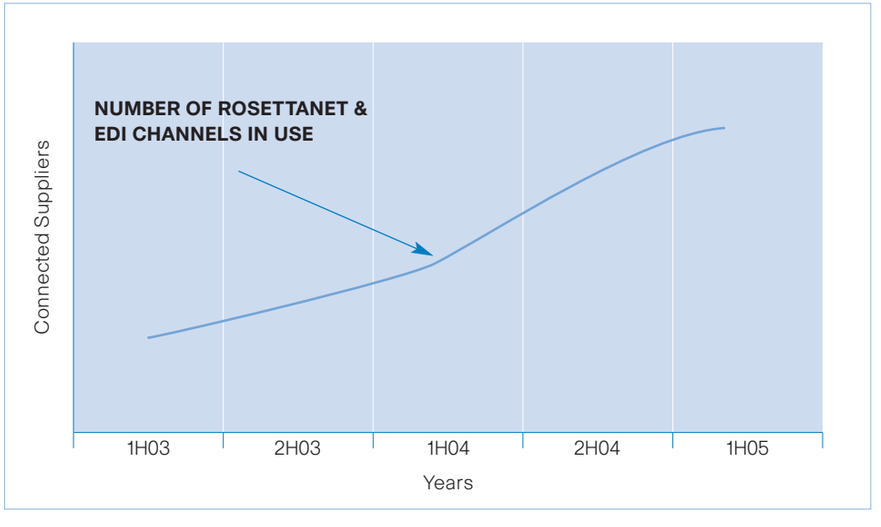



Figure 2 Nokia Corporation, used with permission.

When it comes to tools and connectivity, there is still much to do with our suppliers. RosettaNet is the standard system-to-system interface that we promote to both customers and suppliers, although, there are also some partners with one-to-one electronic data interchange (EDI) interfaces.

### Key focus areas in the infrastructure business

Within the terminals businesses, we have already gained remarkable benefits by having real-time material visibility due to our global, harmonised transaction system platform. Especially in situations where there is a short supply of some components, real-time information about the global material situation is vital. We are now implementing the same platform and processes into our infrastructure business as well. Although lead times of projects are long, they do benefit from real-time material visibility.

There are, of course, also areas where the infrastructure business networks group has been pioneering processes. Take, for example, integrated project management. Electronics components need to be on time in factories, but the components are not the main issue—you need resources, materials, and products to get a site up and running. Full material visibility, then, is the critical first step. The next step is integrated project management, so that we have processes and systems to run the infrastructure project, and integration of materials and resources with those processes and systems.

**Good collaboration with all customers is crucial. The first step is customer-by-customer joint process development.**

There are, by the way, many similarities between terminals business processes and infrastructure business processes. For instance, running campaigns in our terminals businesses is actually a function of project management, which resembles integrated project management in our infrastructure business. Cross-utilisation of processes and systems between our various businesses is an area on which we will focus more in the future. Our current company structure supports this approach well.

### Utilisation of mobility solutions

New solutions based on mobility provide opportunities for productivity leaps. These leaps can be achieved by creating solutions that streamline processes by automating and integrating them through mobile connectivity. Information can be made available for everybody who needs it on the site of the information source, and conversely. Examples of this are the tools and systems for the field sales force or field support staff, as well as for travelling managers or on-site project staff.





The mobile phone is a natural base when we select devices for any mobile connectivity. Mobile phones have been built to last even in rough conditions—unlike laptops, for instance, which aren't as shock-resistant and compact. We are active in developing solutions for people on the move using our own company as a test bench for the solutions.

### Future developments: RFID

Cost-efficient utilisation of radio frequency identification (RFID) is an example of a technology enabler that will, in the future, generate new productivity leaps. The initial usage examples, which are more or less about replacing bar codes with RFID tags, do not bring us there yet. RFID technology also opens up new opportunities in the areas of transportation security and channel visibility, in which RFID technology can bring new value and better information quality.

**Much work is still to be done in connecting processes between corporations. Creating visibility is the key to fast response and flexibility.**

Eventually, when the price of the RFID tag becomes cheap enough and the reliability of the reading technology becomes mature enough, the applications of RFID will be seen everywhere in our daily lives. RFID will become an important element in increasing mobility opportunities.

### Customisation

Advanced customisation capabilities will be crucial in the future. True, we've been customising for some years already—compared with the time when we had three mobile phone models that were all black, we now have tens of thousands of sales package variants that we produce daily in small lot sizes—but we can go much further. Creating mass customisation capability requires close cross-functional work within Nokia, and cross-company collaboration between demand-supply network partners.

Increased customisation will reduce the average lot sizes both for us and for our suppliers. The scope of customisation will be the device (both hardware and software) and the sales package and its content and services we provide for customers. Customisation capabilities open up new possibilities for personalisation as well, such as letting consumers configure their products. There are still some open questions, though, about how to make personalisation cost-efficient.

**The framework for Nokia's continuous focus on its customers**

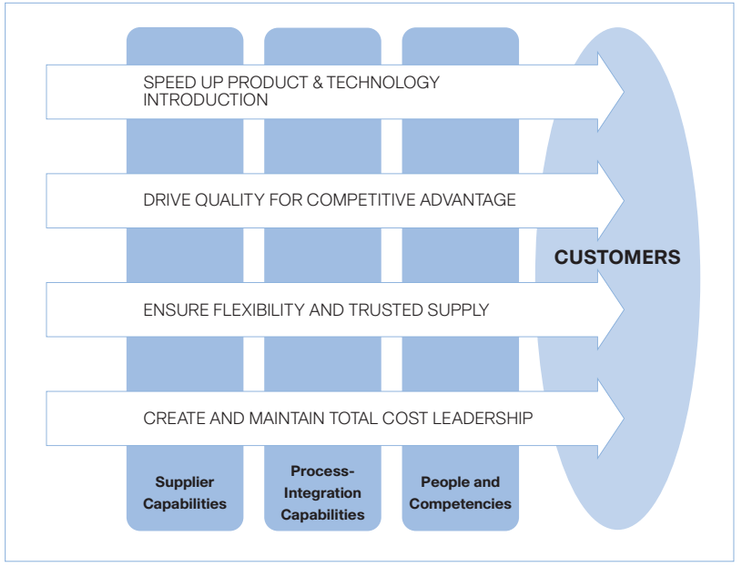



Figure 3 Nokia Corporation, used with permission.

## Summary

To succeed in the future, we will need to combine economies of scale and agility. We don't have too many years to implement this, however—in today's environment, even three years is an eternity. We strive for closer collaboration and better information visibility through real-time connectivity. New processes and systems are needed, but the key to success is enthusiastic, bright, and committed people who know how to implement those new ideas.





**JUHA RÄISÄNEN**

VICE PRESIDENT AND HEAD OF DELIVERY SOLUTIONS, DEMAND SUPPLY NETWORK DEVELOPMENT, NOKIA CORPORATION, FINLAND

Juha Räisänen was formerly in charge of delivery process and solutions for Nokia and led the Demand Supply Network and Care Development initiatives globally for all Nokia businesses. He has achieved success in assuming both executive-level line management positions within manufacturing, logistics, and sales, and in managing development and consultancy organizations.

Previously, Räisänen worked for more than two years in Finland as vice president of operations, logistics, and sourcing for Europe and Africa. Before that, he spent more than four years in Singapore and Hong Kong as vice president, Asia-Pacific logistics, for Nokia Mobile Phones, where he was in charge of outbound logistics for mobile phones in Asia-Pacific and demand-supply network process development in the Asia-Pacific region.

Prior to joining Nokia, Räisänen worked for more than 10 years for Fujitsu/ICL in various positions, ranging from supply chain consultancy to leading the systems integration and software development business units for industry customers in Finland. Since writing this essay Räisänen has left the company.

# 2 CONNECTED SUPPLY

The pioneering companies in this book are not simply looking for lower-cost sourcing—they are creating an entirely new model. The smooth passage of information across the extended value chain allows them to use new customer approaches in both developed and emerging markets, and to innovate more rapidly and efficiently.

ETHERNET'S VALUE PROPOSITION to manufacturers lies in its ability to enable a single network architecture across all enterprise levels.

**Harry Forbes**
SENIOR ANALYST, ARC ADVISORY GROUP

**David W. Humphrey**
SENIOR ANALYST, ARC ADVISORY GROUP, GERMANY

# Industrial IP and Ethernet come of age

**INDUSTRIAL INTERNET PROTOCOL (IP) and industrial Ethernet have come of age. While standard "office" Ethernet with TCP/IP has been used in manufacturing applications at the controller level for more than a decade, Ethernet has now evolved enough to suit the particular needs of industrial users. From harsh environments to high-speed performance requirements, these modifications have opened up countless new application areas for industrial Ethernet.**

ETHERNET'S VALUE PROPOSITION to manufacturers lies in its ability to enable a single network architecture across all enterprise levels—from robot cells to business applications. Using Ethernet at the device level, for example, allows new generations of asset management solutions to extract data directly from networked sensors in the factory. This information is used in real time by sophisticated maintenance or condition monitoring software to predict service problems before they happen, shortening machine downtime and lowering operational costs. Ethernet's ubiquitous IP addressing and routing capabilities enable a level of transparency never before seen in what previously was the domain of proprietary industrial networks.

Ethernet builds bridges between factory and corporate information systems by reducing network requirements to a single architecture, and by eliminating the wall that, for years, has separated the plant from the business world. While this strategy lowers maintenance costs and increases network serviceability, it also supports the proliferation of open standards in the factory. With its universal acceptance in the IT world, solid grounding in international standards, and a wide base of future development directions, industrial Ethernet is revolutionising network communication in industrial automation.

**The worldwide industrial Ethernet device market (thousands of units)**

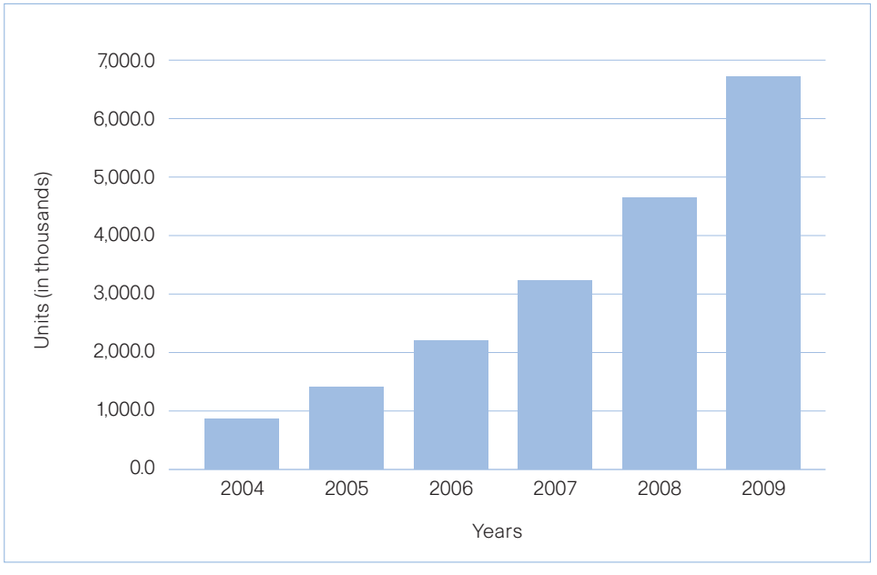



Figure 1 Source: ARC Advisory Group © 2003; used with permission.

During the past few years, a large number of Ethernet-based industrial devices have been brought to market, and many product lines that support multiple device networks have added Ethernet support as well, amid no small fanfare (see Figure 1). Market interest in these new products has been keen, despite difficult conditions in the overall automation market and global economy.

End users have come to realise the potential offered by Ethernet and TCP/IP protocols for endowing devices with Web-based access and similar services. Their familiarity with the potential benefits of such services, and with Ethernet in general, have no doubt propelled growth in this space, despite challenging times and competition from more traditional and entrenched device networks.

The aggregate market volume for industrial Ethernet devices has grown more than 50 per cent annually during the last few years, despite a difficult worldwide market for automation equipment. Development of industrial Ethernet protocols and industrial-hardened products has taken place mostly in North America and Europe, which are also where acceptance of industrial Ethernet is highest.





Automation suppliers have always used industrial networks both as door openers and as tie-in strategies to bind customers to their products. Industrial Ethernet is no different. Battle lines have now been drawn between two major camps: Rockwell Automation in North America with EtherNet/IP and Siemens in Europe with Profinet. These lines were fortified in 2004 through endorsements by General Motors for EtherNet/IP and a consortium of Germany's top four automakers for Profinet. Asia-Pacific suppliers and end users have been more passive in the network arena, and the markets there for industrial Ethernet are currently wide open.

In Asia-Pacific, we see the uptake of IPv6 (next-generation Internet Protocol) increasing more rapidly as U.S. and European camps drive, mainly, their proprietary strategies. Both in industrial automation as well as in building automation, Asia-Pacific companies are likely to overhaul current proprietary strategies with IP-enabled plant and IP-enabled building devices during the next two to four years. We believe this strategy will force market leaders to standardise using IP-enablement of their products and services portfolio—not just by standardising on Ethernet, but also by standardising on the protocol layer by enabling quality of service and security end to end.

While many diverse kinds of devices incorporate Ethernet interfaces, they have little in common other than their Ethernet physical layer. Ethernet and the TCP/IP protocol suite are inseparably linked in the IT world, but the same is not the case for these industrial devices. However, adoption of a common physical layer, combined with Ethernet's multiprotocol ability and the many strategic advantages that come with support for TCP/IP, indicate that widespread adoption of Ethernet will offer new opportunities for advances in automation and for simplification of systems integration. These kinds of developments have been elusive during the decades-long struggle over the digital industrial Fieldbus.

A large number of forces are contributing to the rapid growth of Ethernet networks at the device level. Many of these same factors have propelled this acceptance to higher levels of the automation hierarchy as well, where Ethernet is now dominant. Device-level industrial networks, however, have distinct requirements. Not all of these requirements are addressed by today's industrial Ethernet technology or products, which give market strength to the various device networks (see Figure 2). Ethernet technology, however, is not standing still. In addition to ongoing research and development efforts within the IT sectors and academia, a growing number of suppliers are working to create

**Industrial Ethernet is penetrating networking domains traditionally served by well-established fieldbuses and device networks**

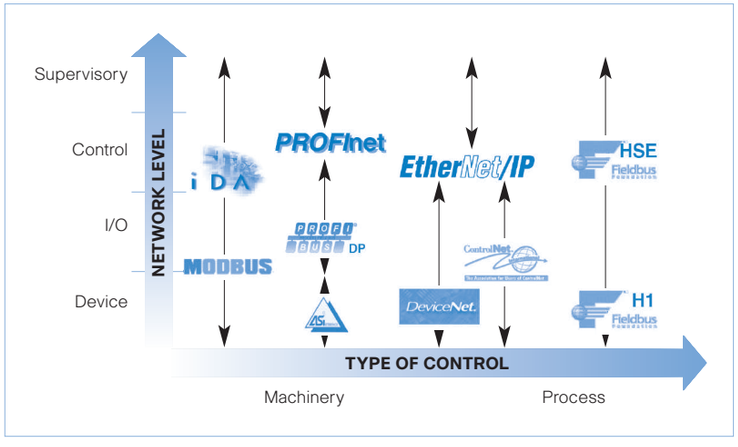



Figure 2 ARC Advisory Group, used with permission.

Ethernet-enabled products tailored for industrial use. Also, some of the larger IT-related suppliers show a renewed focus on the manufacturing sector, following the bursting of the Internet bubble market that fed their growth through the late 1990s. Key factors now contributing to the success of Ethernet at the device level include:

- Ethernet's widespread commercial acceptance
- Ethernet's position as a common network architecture
- Ethernet's presence in vast, worldwide IT industries
- Ethernet's higher degree of protocol independence
- Growing availability and variety of industrial Ethernet products
- Ability of industrial Ethernet products to address wider markets
- Expected future Ethernet capabilities, especially power over wire





## End users benchmark Ethernet products and solutions

With so much recent expansion in the supply base of Ethernet products, end users remain in a learning mode with respect to adoption. While there is vast experience with Ethernet per se, end users have much more limited experience with new industrial Ethernet products. Suppliers find that the level of inquiry regarding their new Ethernet products is significantly higher than Ethernet's current share of shipments. In general, suppliers remain optimistic that significantly higher volumes are in the offing.

End-user reluctance toward new Ethernet products is shared in the area of distributed automation capabilities, which Ethernet has spurred. These technologies are still being developed, and the number of products that currently support them is limited. Major automation suppliers, however, are promoting these technologies as competition moves away from vendor control of automation networks. End users are working with such products with a view toward creating both a greater experience base and a simplified set of benchmarks or design rules that will provide them greater assurance—not only of device interoperability, but also of overall system performance, which is the overriding concern of the manufacturer.

## Supplier deployment of Ethernet pushes real-time limits

Ethernet devices fit naturally into information-oriented applications, which overwhelmingly employ TCP/IP. One gauge of supplier interest in Ethernet is their willingness to deploy Ethernet in applications whose real-time performance requirements stretch the limits of Ethernet's capabilities. In some cases suppliers have chosen deployment of Ethernet as a pure physical layer, discarding TCP/IP at the lowest level in favour of protocols that can give higher performance in small devices. In such solutions, Ethernet loses its key advantage as an enabler of potentially worldwide remote access and service through Web technologies.

In most cases, suppliers have chosen to supplement TCP/IP with other protocols or capabilities that allow them to extend Ethernet's reach deeper into the real-time arena, creating the potential for vendor differentiation via proprietary extensions, which is a long-running issue for end users and suppliers alike. In many cases, given the recent arrival of Ethernet at the device level, users are uncertain of what constitutes a set of reasonable performance benchmarks; they are willing to adopt products that carry some risk of vendor-lock in return for simplified performance metrics that allow them to proceed faster with system-level

designs. In the longer term, greater experience will alleviate this concern, as will the relentless technical progress Ethernet enjoys due to its massive worldwide adoption.

### Future device platforms spur both Ethernet and wireless

Improved tools for embedded systems now allow suppliers to employ much more device capability directly from their development environment. This benefits Ethernet deployment because much of this off-the-shelf capability is oriented toward Ethernet devices. Ethernet's ability to simultaneously support multiple communication protocols matches the features of these embedded toolsets to offer a cafeteria-style menu of features.

In addition, the next one to two years will see the introduction of many small devices with new sets of capabilities. Such introductions will be fuelled by new hardware platforms that will support not only Ethernet, but also embed sophisticated support for secure wireless communication. These new platforms are initially targeted at the high-volume consumer and IT segments, and will take some time to penetrate the industrial space. The platforms incorporate lower power consumption and battery life extension as part of their base-level features because they are targeted specifically at battery-powered and handheld devices. Thus their design basis makes them better suited for industrial requirements, in contrast with much of today's office-oriented hardware and chipsets.

### Intelligent implementation now extends to administration

Ethernet networks in automation must be implemented by design rather than in an unplanned fashion. The need for design rigour extends from the physical planning of the network to its more IT-oriented properties, such as service provision, routing, firewalls and network security. The need for intelligent implementation, while significant, can be met without creating a barrier to Ethernet adoption. Ethernet and TCP/IP can draw from a much larger pool of human resources and information resources for support than any other network.

Furthermore, enterprises of all sizes now already depend upon large Ethernet and TCP/IP networks for their routine business processes. Ethernet networks in manufacturing represent one special case of support requirements; whereas, device networks require a completely distinct skill set that is in significantly shorter supply.





The concept of "intelligent implementation" for industrial Ethernet has been defined as a network design where the following characteristics exist:

- Each device sees a full 100MB, full-duplex channel
- Packet collisions are eliminated through active switching
- Connection of plant networks to the enterprise network is managed

In the future, the concept of intelligent implementation will extend to a much broader concept that includes a corporatewide view of network security. Again, this is not a problem caused by Ethernet in manufacturing per se. Rather, it results from the requirement that all enterprises will inevitably face with their networks and operations as they begin to deal with service delivery to mobile and wireless clients as opposed to fixed desktops or work cells. This issue will need to be managed in the IT domain, and the solutions created in that domain can be adopted by Ethernet in manufacturing.

### The changing face of plant-floor networks

In a recent survey, ARC investigated manufacturers' practices with respect to plant-floor or process-control networks. While the majority of manufacturers have defined such networks, we found that their practices and policies vary widely—a fact that can only partially be explained by variables, such as vertical industry and size of the enterprise. The results underline the importance of not making generalisations about plant-floor network practices—they vary widely within the manufacturing sector, emphasizing that as difficult as they may be to gauge, incremental risk and benefit are the relevant metrics for formulating network policies.

**In the future, the concept of intelligent implementation will extend to a much broader concept that includes a corporatewide view of network security.**

ARC surveyed manufacturers' practices for isolating, accessing, securing, and administering process-control or plant-floor networks. We received 186 responses. First, we asked, "Does your plant have a separate, specifically identified process-control or plant-floor network?" More than 80 per cent of survey respondents answered "Yes." The more interesting question concerns the companies or locations that do not differentiate the plant-floor network. ARC found that these repondents come from a variety of industries, geographies, and company sizes that are not significantly different from the entire sample. These companies do tend to be from discrete rather than process manufacturing operations. Some manufacturing operations network their PC-based plant-floor equipment and apply their normal IT practices to add such systems to the enterprise network. In effect, the PC acts as a layer of isolation between automation networks and enterprise networks. While such plant networks are a distinct minority, they do exist, and not only within small enterprises. In the following analysis, these responses have been excluded, as have the responses of equipment suppliers.

The next question we asked was: "Which technologies do you employ to isolate this network from other networks and back-office applications?" Respondents were allowed only a single choice from a menu of increasingly stringent separation options. Clearly, this separation point is designed to be a well-guarded boundary. A third of the respondents maintain separate networks, while more than 40 per cent use firewalls and 14 per cent use virtual private networks. The appeal of physically separate networks from a security standpoint is understandable; they remove external Web browsing and external e-mail, which are major sources of virus and spyware infections. The downside of this benefit is the added cost and complexity of administering separate networks. Maintaining strict network separation also inhibits the integration of these manufacturing operations with enterprise applications—a high price to pay for incremental security.

"Who is allowed access to the plant-floor network, from where, and for what purposes?" When we asked these questions, we found that the majority of plants provide access only at the manufacturing location or at a limited number of locations within the plant. The survey also found that 70 per cent of respondents require a separate authentication process for access to their plant-floor network. The caution with which manufacturers grant access to these networks suggests that factory equipment suppliers and solution providers will have greater success





with expanded offerings if their products can utilise a manufacturer's enterprise network rather than the plant-floor network—the former network will offer far fewer barriers to integration. Asset management applications, such as equipment condition monitoring, can be designed to work this way, especially in the coming era of wireless sensor networks. These applications can use existing services for obtaining the plant-floor information they require, but do not need to keep their own information stores and resources within the highly restricted plant-floor network.

**ARC found that roughly one-third of respondents allowed software services, upgrades, or equipment configuration to be done from a remote location.**

When we asked, "Who is allowed to have access to the plant network?" the interesting result was that almost half of the respondents allowed some nonplant personnel to access their networks. Original equipment manufacturers (OEMs) and automation suppliers were less likely to enjoy this privilege, but a quarter of the respondents did let automation suppliers or OEMs have access. In terms of what kind of work could be done remotely, ARC found that roughly one-third of respondents allowed software services, upgrades, or equipment configuration to be done from a remote location. Remote monitoring and troubleshooting were much more prevalent: only 10 per cent did not permit any remote operations, but this small percentage included respondents from several major manufacturers.

A number of different technologies are used to implement remote access to the plant-floor network. The most popular is an application with access to the plant floor that provides a widely accessible service on the enterprise network. This application is a common configuration for many data historian packages. Only 10 per cent of respondents reported that they ran remote service offerings provided by their equipment OEMs. Hence, our conclusions find that it is important not to generalise about plant-floor network practices, and that incremental risk and benefit are the relevant metrics for formulating network policies.

Manufacturers, then, must ensure these three fundamental building blocks—appropriate machine selection, interoperability and interchangeability between machines, and optimal networking solutions—are all in place if they are to realize truly connected manufacturing. Achieving each will be critical for businesses if they are

to adapt to tomorrow's demand-driven business model, where agility and flexibility will provide the responsiveness on which manufacturing operations will depend for future success.

**HARRY FORBES**

SENIOR ANALYST, ARC ADVISORY GROUP

Harry Forbes is part of the Collaborative Manufacturing and Automation consulting team at ARC. He consults in the area of industrial networks—from Ethernet and device networks to wireless—for clients in power generation and industrial generation management. An expert in process automation, system integration, TCP/ IP, industrial network technologies, and network security, Forbes also has more than 25 years of experience in power generation, industrial energy management, simulation modeling, advanced control and optimization, automation system sales, and product marketing management. Before joining ARC in 2002, he worked for Invensys, where his assignments included project management, marketing management, sales, and engineering of major PAS and training simulator projects. Forbes received a master's degree in business administration from the University of Michigan and a bachelor's degree in electrical engineering from Tufts University.

Forbes is an author in the areas of automation network architecture and power generation. He is responsible for ARC's influential "Ethernet at the Device Level" study and has also written for *Control Design* and *Power* magazine, and industry conference publications. His ARC articles include *Will Cogeneration Go 'Micro?*'; *Not Your Father's EPRI: New Life for Old Nukes*; *Management of Industrial Ethernet Networks*; *IEEE 1451: Less is More*; *RFID: A Considerable Speck*; and *Wireless I/O: The Electrician's Radio*.

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David W. Humphrey is part of the automation consulting team at ARC, covering manufacturing topics in Europe. He is a member of ARC's hybrid manufacturing, packaging, and industrial networking teams, as well as a member of the OMAC (Open Modular Architecture Controls) Packaging Workgroup Executive Committee. In addition to automation, Humphrey looks at economic topics affecting manufacturers and is the author of ARC's annual survey report on capital spending.

Before joining ARC, Humphrey was area manager for automation solutions in Rockwell Automation's Munich, Germany office. In addition, he worked for several years for Raytheon Company in the United States. Humphrey holds a bachelor's degree in electrical engineering and computer science from Stevens Institute of Technology, as well as a master's degree in business administration from the Business and Economics University of Vienna (WU Wien) and the University of South Carolina, with a concentration in international business. He has authored the following ARC publications: *Capital Expenditure Survey* (annual), *Safetybus Systems, PLC Supplier Preferences*, and *E- Business Strategies for OEMs*.

SMOOTH EXECUTION of supply-chain operations relies on appropriate execution of business processes across the whole value chain, including suppliers and partners.

**Christian Verstraete**
SENIOR DIRECTOR, MANUFACTURING AND DISTRIBUTION INDUSTRY SOLUTIONS, HEWLETT-PACKARD COMPANY, UNITED STATES

# Developing an adaptive supply chain through partner collaboration

**INCREASINGLY, COMPANIES OUTSOURCE elements of their supply chains and rely on partners to develop, manufacture, and distribute their products or services. In doing so, they rely on networks of suppliers and service providers to establish a sustainable, competitive advantage and increase shareholder value. Such networks are usually referred to as ecosystems or extended enterprises.**

WITH THE PASSAGE OF NEW LEGISLATION related to safety and environmental concerns in many countries, such extended enterprises must consolidate product and process-related information across company boundaries. An electronically connected supply chain is the means to achieve this.

In this essay we address how leading companies may want to look at their partner ecosystems to improve their responsiveness while reducing costs.

Hewlett-Packard (HP) has integrated several approaches to develop an adaptive supply chain designed to cope with disrupting events such as changes in market demand, parts obsolescence, or disruptions in manufacturing or logistics while at the same time improving profitability.

## An adaptive supply chain

HP's supply chain manages about US$51 billion of the company's spending, delivering more than 200,000 stock keeping units (SKUs) to a billion customers in 178 countries. HP's supply chain coordinates the activities of 32 manufacturing plants, 88 distribution hubs, 700 suppliers, and 119 logistics providers. The company ships 1.3 million cartridges, 110,000 printers, 75,000 personal systems, and 3,500 servers to markets daily via 11 routes.

**Hewlett-Packard's supply-chain activities**

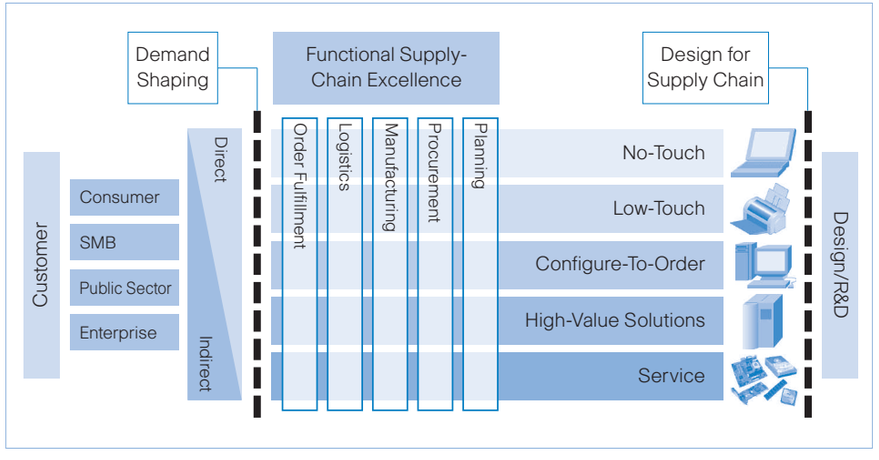


Figure 1 Hewlett-Packard, 2006; used with permission.

In the late 1990s, HP outsourced most of its supply chain and standardized all supply-chain activities into five categories:

- **No-touch:** products shipped directly from contract manufacturers to customers and partners
- **Low-touch:** products made by HP and shipped in bulk
- **Configure-to-order:** customer-configured products via multiple supply chains
- **High-value solutions:** vertical and customized solutions
- **Services:** spare parts for warranty and repair

HP addressed this complexity from three angles: people, processes, and technology.

### People

An efficient supply chain means working closely with key suppliers and building collaborative relationships. This required developing trust between HP and its partners and proved to be a time-consuming task. Furthermore, HP outsources up to 90 percent of its manufacturing, so close integration with contract manufacturers (CMs) is a must.





Nonetheless, as recent as the late 1990s, HP was working with 55 different CMs, and was not a significant customer for any of them. HP then created a Manufacturing Outsourcing Strategy Team (MOST) and identified six preferred partners, with the objective of passing most of the business through them.

A governance structure covering both the central teams and the businesses has been operational for the last four years. This structure centralizes management of the overall relationships with contract manufacturers, including contracts, business processes, service-level agreements, strategic initiatives, and reviews.

Day-to-day relationships are handled by the businesses. MOST is responsible for growing the relationships strategically, while executive sponsors partner with the CMs' top management, providing a timely escalation path if needed. Twice a year, MOST and segment managers review the business with each contract manufacturer and examine strategy developments.

Over the last year, the use of original design manufacturers has grown as HP increasingly developed new products in partnership with other companies. Learning from the approach taken with the CMs, HP expanded the role of MOST and renamed it the Design & Manufacturing Outsourcing Strategy Team.

### Processes

When collaborating with partners, getting a clear definition of process and who performs them is critical for smooth operations. To achieve this, HP has adopted industry-standard supply chain operational reference (SCOR) processes.

This reference model has given HP the opportunity to benchmark itself against other companies. This, in turn, helps the company improve those processes where it finds itself lagging. The Supply Chain Council runs regular benchmarks, based on SCOR's key performance indicators (KPI), which enable cross-company comparisons to be made within the sector. This means HP can focus on areas where it lags and re-engineer strategic processes.

This approach is a real asset when unexpected events occur. For example, HP's supply chain is regularly disrupted by hurricanes that affect its Taiwanese suppliers. Risk mitigation and scenario planning smooth out this disruption by identifying alternative business processes and supply sources.

## Infrastructures

To facilitate collaboration and accelerate information transfer with its partners, HP created a private hub called KeyChain, which enables secure execution of transactions between partners; this means that HP can share forecasts, send and follow up on purchase orders, and support supplier-managed inventory collaboration models.

**KeyChain™ logical integration architecture**

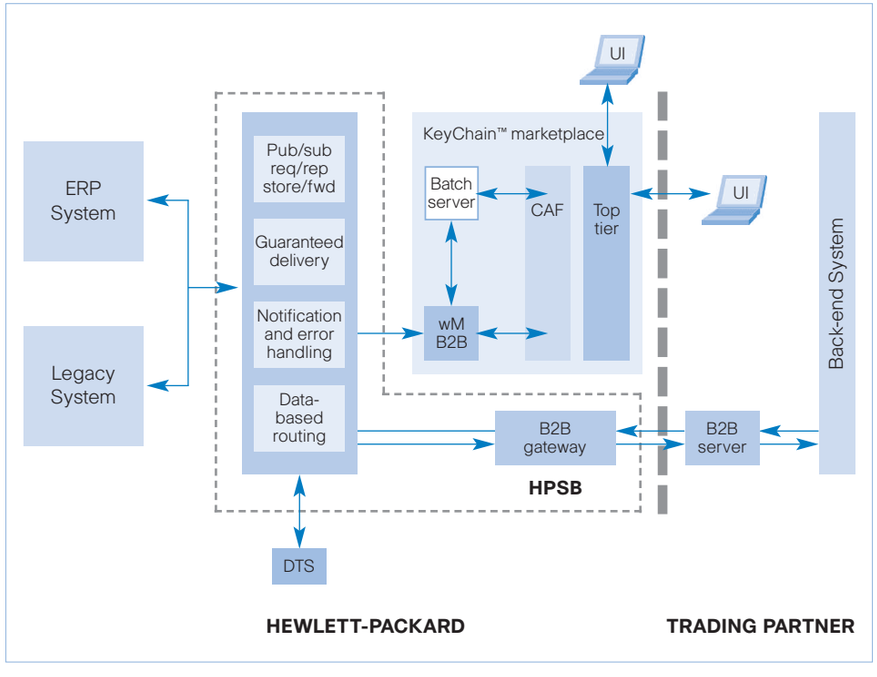


Figure 2 Hewlett-Packard, 2006; used with permission.

Suppliers can interact in two ways with the system: They can log onto the hub and browse their private pages, entering requested information; alternatively, they can perform business-to-business transactions between their systems and KeyChain. When using KeyChain, HP favors the use of standards, such as RosettaNet or electronic data interchange, but provides translation capabilities for suppliers using nonstandard formats. Reliant on an Internet backbone, KeyChain manages both communication approaches mentioned above and integrates the information supplied with the HP back-end systems, as shown in the architecture presented in Figure 2.





## Optimizing the supply chain

In its continuous quest to reduce costs related to the supply chain, HP looked outside the electronics industry to find creative ways of approaching partner collaboration. Variable demand is one of the biggest cost components, especially in the IT industry, where demand can vary significantly and prices can drop suddenly, leaving the supply chain with unwanted inventory. HP has developed a methodology for managing variable demand and for mitigating risk.

Many companies have experienced the “bullwhip” or “forester” effect, by which a small variation at one point in the supply chain propagates with ever-increasing amplitude through the whole chain. This mechanism leads to excess inventory and shortages that become very costly.

Figure 3 represents the variation of stock, based on changing demand. Suppliers see the varying demand, and because they have only limited visibility into the reasons behind that variability, they use planning assumptions that may not reflect the real demand. The result is a drastically varying inventory.

**Stocking level for nonsynchronized orders**

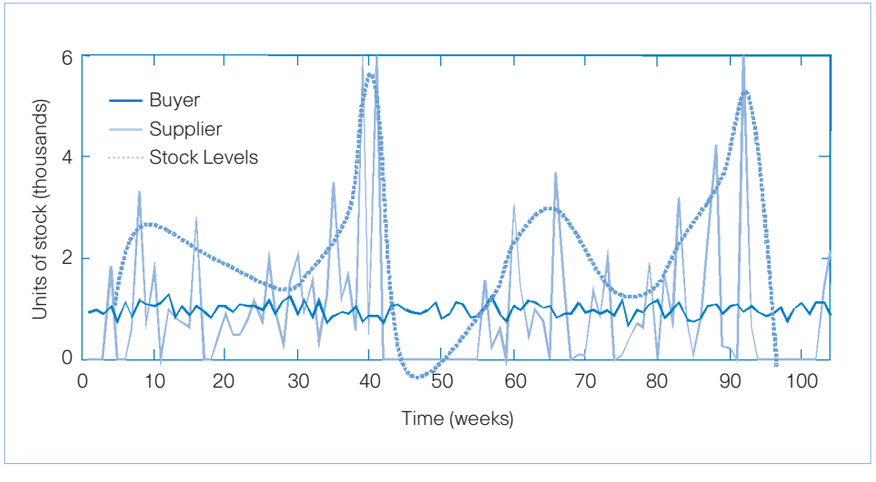


Figure 3 Hewlett-Packard, 2006; used with permission.

**Stocking level, synchronized orders**

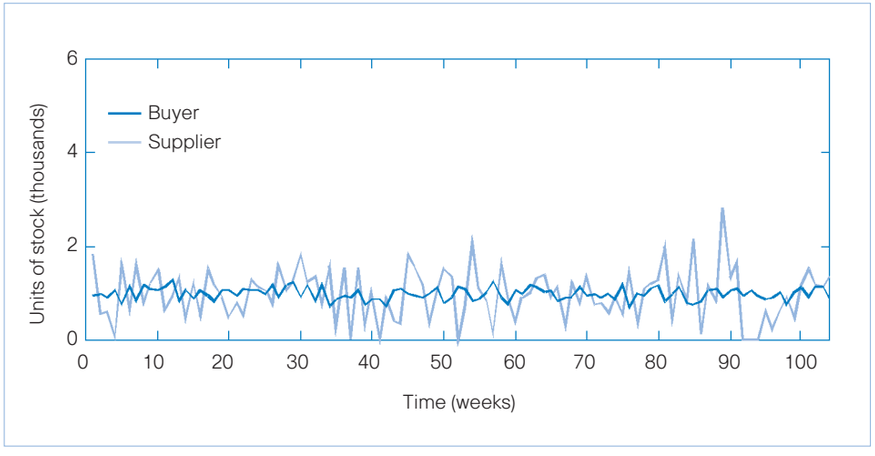


Figure 4 Hewlett-Packard, 2006; used with permission.

If suppliers could see the real customer demand and shortages, supplier inventory would be kept under control (see Figure 4).

An even better approach is allowing suppliers to manage inventories. Management of stock available in the supply chain implies giving suppliers visibility into real customer demand. Known as supplier-managed inventories (SMI), the technique was pioneered by Wal-Mart and Procter & Gamble.

### Dynamic replenishment*

Using the same principles, but taking them a step further, HP automatically calculates optimum stocking levels and dynamically adjusts shipments based on the supply chain's current status—a process known as dynamic replenishment (DR). The result is quick, preemptive resolution of supply-and-demand imbalances across multiple HP sites and suppliers.

DR needs high levels of supply chain systems integration (which may preclude some partners from participation), as well as significant changes in current business processes and concurrent management of change investment. With strategic partnerships, however, the rewards can be substantial.

* *Inventory Collaboration, the Next Generation Partnership*, HP White Paper, March 2003.





DR removes HP from tactical supply-chain management and gives trading partners the information they need not only to manage variability in HP demand, but also to keep their production lean and efficient. Inventory collaboration (SMI & DR) contributes dramatically to synchronizing the supply chain, effectively shortening it and increasing inventory velocity. This is especially beneficial in multi-tiered, complex environments, while global visibility of inventory and demand allows for better decision making, faster reactions, and lower cost.

### Procurement risk management**

HP operates in a highly volatile market. Building long-term relationships with suppliers in such a market requires risk mitigation.

In 1999 and 2000, HP faced significant price increases and an availability shortfall for flash memory that adversely affected its printer lines' profitability. To assure future availability of flash memory, and to protect its printer profits, HP entered into a binding, long-term contract with a major flash supplier. Uncertainty about the future prices and availability of flash memory—and about HP's own demand—made specifying terms and conditions for the contract very difficult. So, HP had to evaluate the following questions:

- What should it pay for flash memory over the next few years, and how should it structure its payments?
- How much should it buy, and how should it structure delivery terms?
- How long of a horizon should the contract cover, and what would be the best time to sign the agreement?

To address these questions, HP developed a framework called procurement risk management (PRM). The system uses statistical commodity-price forecasting analytics that can account for unexpected turns in cyclical markets and technology trends, similar to the financial models used on Wall Street.

Prices and availability of semiconductor-based components reflect significant uncertainties. For example, the price of memory dropped more than 80 percent in 2001, then tripled within a three-month period. Such dramatic and unpredictable swings in component

** *Procurement Risk Management*, HP White Paper, March 2003.

prices can render finished products unprofitable, especially when prices are negotiated months in advance based on highly uncertain forecasts. Product demand is also uncertain, which increases costs. HP's suppliers then face risks such as capacity underutilization, inefficient finished goods, and inventory write-downs. As a result, suppliers factor those costs into their prices.

**Hewlett-Packard's procurement risk management**

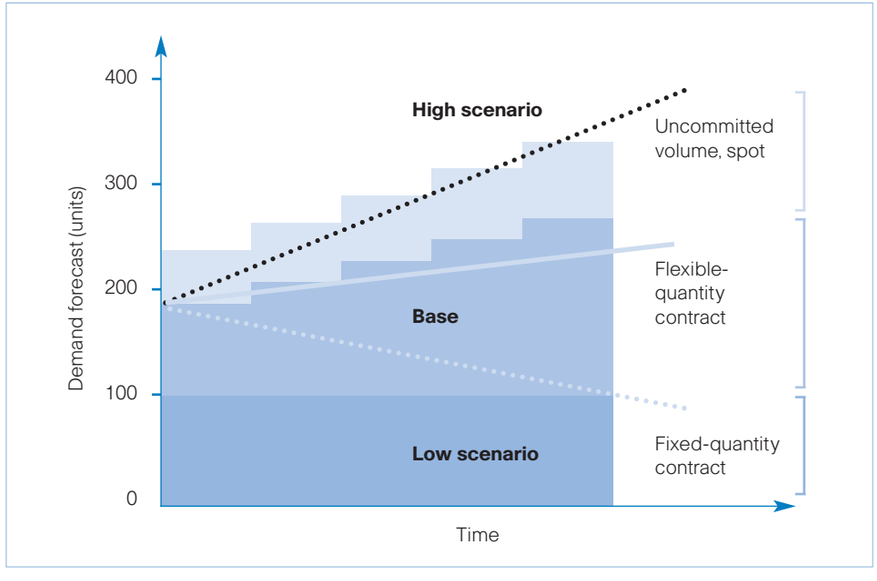


Figure 5 Hewlett-Packard, 2006; used with permission.

PRM recognizes the volatility of demand (see Figure 5). PRM allows greater flexibility to capture cyclical and technological trends, and to help mitigate the risk of running out of components, while recognizing the volatility of their demand.

HP has used PRM for many commodities since 2000, saving hundreds of millions of dollars in the last four years. By combining stock-market techniques and in-depth knowledge of the IT industry, HP has mitigated its risks.

By outsourcing its manufacturing, HP has come to realize the importance of considering manufacturing facilities when developing new products.





**Supply-chain design**

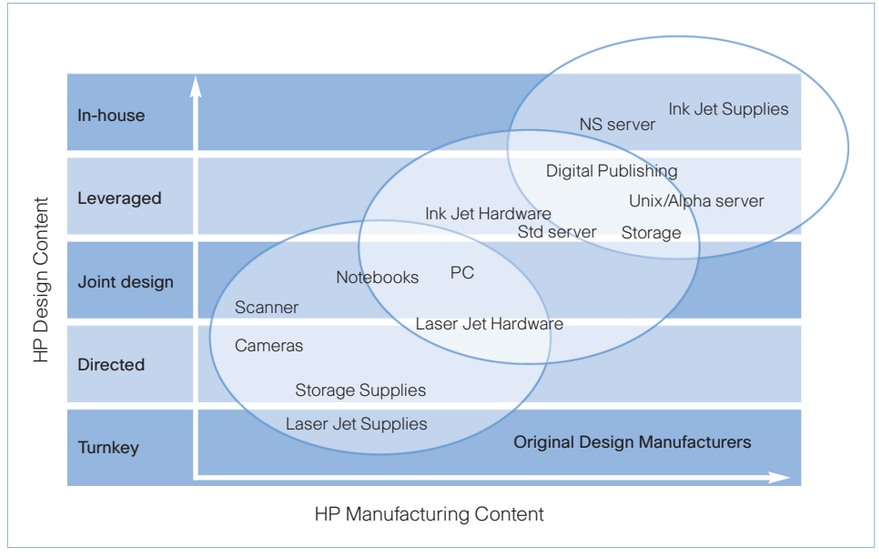


Figure 6 Hewlett-Packard, 2006; used with permission.

HP has expanded the "design for manufacturability" concept, popular in the 1990s, to include the supply chain; this allows portions of the product-design process to be performed by partners, along with strategies developed by HP specifically for each product family. Partner collaboration by electronic means is critical to the design process, as both parties need access to product specifications and engineering changes to shorten a product's time to market.

Additionally, with the aim of enhancing profitability through the use of packaging-optimization tools, supply-chain simulation models, and parts-reuse analytics, HP has developed a process to trade off supply-chain responsiveness and material, and supply-chain costs. Examples include designing packaging to maximize the number of products on a pallet, reducing transportation costs, and postponing and standardizing components.

## Moving forward

The supply chain is always under cost pressure, but advanced companies have found ways to reduce these costs drastically. Further savings can be realized only by integrating the supply chain with both design and demand chains. And only by integrating more closely with

key suppliers and partners can the supply chain be made more agile.

Integration requires two approaches, both of which require connectivity at the business level:

- Using end-to-end business processes to cope with variance and unexpected events
- Developing a portfolio of collaboration approaches to create a sustainable, competitive advantage

### End-to-end business processes

All companies must manage both market variability and disruptive events, such as material shortages and component obsolescence.

**Visualization of cost of latency**

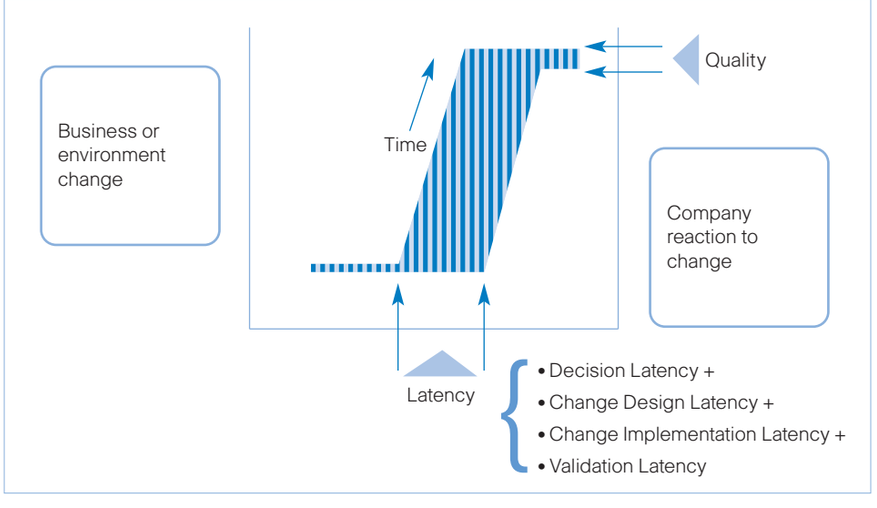


Figure 7 Hewlett-Packard, 2006; used with permission.

Reactions to events involve latency—if latency can be minimized it will reduce costs and lead to a more efficient supply chain. In Figure 7, we visualize this by assuming a step-change that triggers a response in four distinct categories in the business environment:

- **Decision:** Will the event have a lasting influence on the supply chain (for example, eliminating transient variances), and will it require a change in supply-chain processes?





- **Change design:** Do new partners need to be integrated in the supply chain? Do inventories or demand levels need to be adapted, or do key business processes require redesign?
- **Change implementation:** How long will it take to make the changes work?
- **Validation:** How do we assess the effectiveness of the changes?

Two key elements are then used to measure the quality of the response. First is the speed of the organization's reaction (latency); second is how closely the change addresses the new situation (quality). In Figure 7, the shaded area corresponds to the lost opportunity (the smaller the surface of the shaded area, the better the response). An agile supply chain can minimize lost opportunities by reducing latency; this involves designing and documenting supply-chain business processes, and performing scenario-planning exercises ahead of time.

Defining business processes clearly, measuring them, and benchmarking other companies all help improve an organization's responsiveness. Doing the same across the supply chain has a similar effect on the extended enterprise.

First, one needs to document processes, clearly establishing them to help ensure a consistent execution. This process creates an understanding of the steps executed and streamlines operations.

As outlined earlier, HP uses process standards such as SCOR*, the supply chain operational reference model. As this model addresses only the supply chain and describes neither design activities nor customer interactions, HP has extended the concept and also uses two similar models: DCOR (for the design chain) and CCOR (for customer interactions). These models have been handed over to the Supply Chain Council as standards in their own right.

All three models define how business processes interact with those of suppliers and distribution partners. One may want to take advantage of these features and document processes along the whole chain to help ensure a consistent and lean execution of the entire supply chain.

The models also establish key performance indicators for each of the major processes. By comparing a company's KPI results with those of other companies, operational effectiveness can be compared. Key performance indicators are typically measured at a company level, but

* See SCOR version 7.0 Overview at www.supply-chain.com.

to measure a supply chain's effectiveness, KPIs should be measured at an extended enterprise level. This allows identification of problem areas.

Today, however, this can be achieved only by reviewing members of the extended enterprise separately. No communication standards exist at the business-process level yet, making it difficult to visualize the end-to-end process. Proper identification of the transactions executed between partners, however, allows an understanding of how the process evolves.

In the example in Figure 8, shipment notifications establish that the contract manufacturer has finished the manufacturing process and

**Example of information—process linkage**

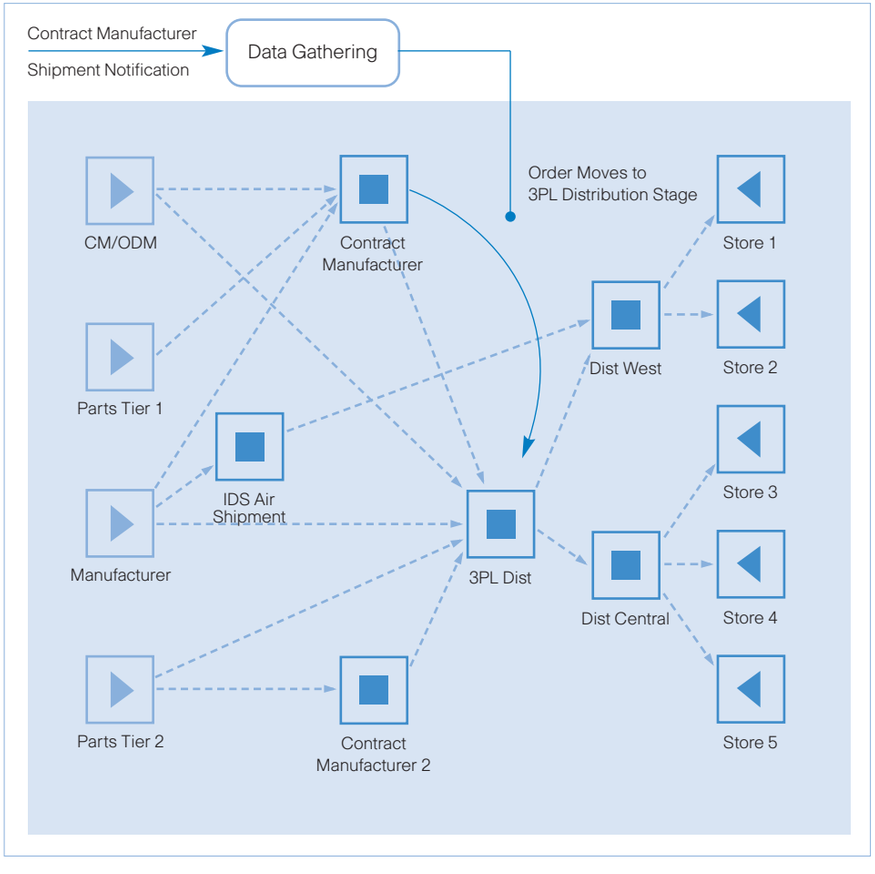


Figure 8 Hewlett-Packard, 2006; used with permission.





shipped the goods to the 3PL distribution center. Such visualization provides visibility into how activities are executed across the extended enterprise, giving a first glimpse at where improvements can be made. Documenting, measuring, and visualizing business processes will provide many opportunities to improve supply-chain operations across the extended enterprise.

### Partner segmentation and collaboration*

As we see in Figure 8, smooth execution of supply-chain operations relies on appropriate execution of business processes across the whole value chain, including suppliers and partners. Too many companies have approached business partners in a confrontational manner. For the best outcome, whether product or service, optimal working relationships with key partners are essential. This means commodity partners and key suppliers need to be treated differently.

Where multiple supply sources exist, commodity partners can be approached in a confrontational manner, as cost is the only factor in the relationship. Deciding whether to keep the supplier at arm's length or whether electronic interactions are required is important, but cost negotiation is key.

Suppliers of key goods and services that differentiate the end product are instrumental in that product's success. Having those suppliers working with the competition may, in some cases, even harm the success of the end product in the marketplace. Such suppliers require attention and should be approached differently. When negotiating with them, price should not be the only factor under consideration. Cost is important and a fair price should be paid, but a win-win approach is needed to secure the supplier's willingness to build a collaborative relationship.

This requires the establishment of trust, which may take time with partners who have previously been treated confrontationally. In many situations, such relationships go beyond the delivery of goods and services; they include codevelopment and R&D, to make sure that the usage of the supplier's products and services is optimized in the end product.

Once the relationship has taken that new, collaborative approach, the development of common business processes and the establishment

* *Collaborative Sourcing*, Philippart, Verstraete, Wynen, PUL, October 2005.

**Partner and supplier segmentation framework**

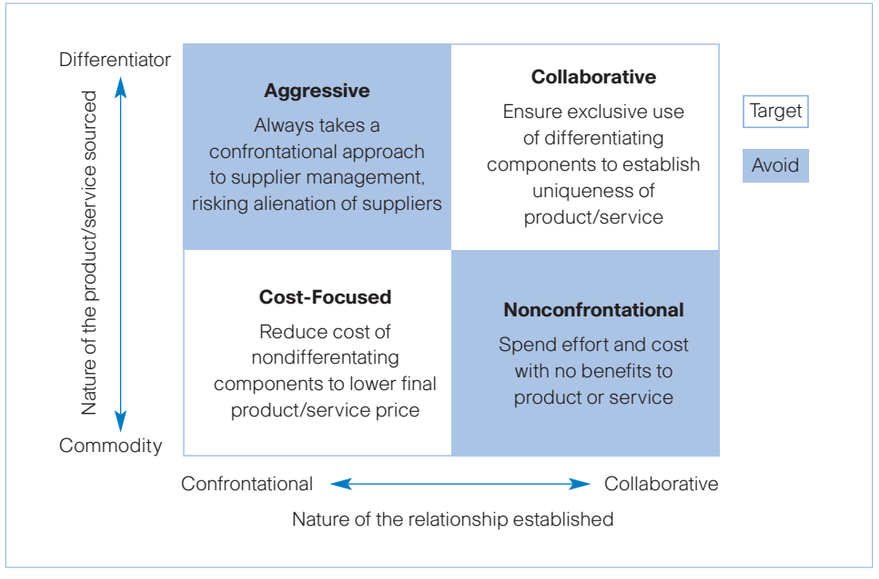


Figure 9 Hewlett-Packard, 2006; used with permission.

of appropriate infrastructure components that securely interact with each other will foster the relationship—and establish a robust platform for cooperation.

This often implies single sourcing, as establishing such relationships takes time and effort. Single sourcing will force buyers to mitigate risk and have alternatives ready in case of failure. Such collaborative approaches require a new breed of professionals, often not available in today's procurement departments. They position the chief procurement officer as the person responsible for the company's external resources.

## Summary

Advanced companies have spent much time and effort optimizing their supply chains, and are now focusing on supply-chain design, interaction of the design and demand chains, and demand management. By looking at business processes across the extended enterprise, visualizing them, and understanding where bottlenecks exist, companies can improve the efficiency and agility of their supply chains. Working closely with key suppliers, they can establish a network of





partners critical for differentiation of their end product, and help to ensure a sustainable, competitive advantage.

Companies need to connect their supply chains to enable a constant flow of information among partners, providing early notice of problem areas and, ultimately, improving the satisfaction of their end customers.

**CHRISTIAN VERSTRAETE**

SENIOR DIRECTOR, MANUFACTURING AND DISTRIBUTION INDUSTRY SOLUTIONS, HEWLETT-PACKARD COMPANY, UNITED STATES

Christian Verstraete has been a member of Hewlett-Packard's management team for more than 20 years and today manages the development of the solutions HP proposes to the manufacturing and distribution industries. Verstraete directs the alignment of internal organizations and external SI/ISV partners for integrated solution value chains for the manufacturing and distribution industries, as well as for the design of industry-specific go-to-market initiatives and solutions, based on HP's own best practices in supply-chain management.

Prior to his current role, Verstraete has led the high-tech industry practice, representing more than US$5 billion in revenue for HP. He also ran the manufacturing practice within HP's Consulting & Integration business unit, which consists of 1,200 global consultants who design and deliver solutions in the areas of supply chain, procurement and sourcing, product lifecycle collaboration, demand chain, and collaborative business integration. In addition, Verstraete has held a variety of management positions, both regionally and worldwide, in business development, marketing, consulting, and project management. Over the years he has advised multiple Fortune 100 companies on how to use their IT assets to create additional stakeholder value and embrace new market opportunities.

Verstraete holds a degree in mechanical engineering from the Universite Catholique de Louvain in Louvain-la-Neuve, Belgium, and has a degree in industrial management from Katholieke Universiteit van Leuven in Leuven, Belgium.

A LACK OF VISION and both entrepreneurial spirit in top management levels of retailing and manufacturing is a major issue affecting modernisation of the retail industry.

**Zygmunt Mierdorf**
MEMBER OF THE MANAGEMENT BOARD, METRO GROUP, GERMANY

# Expectations of manufacturers: connecting demand side with supply side

MAKING A COMMITMENT TO NEW TECHNOLOGIES IS WHAT METRO GROUP IS ALL ABOUT. **In keeping true to its word, METRO is investing time and resources into optimising its supply chain and its practical support of suppliers of all sizes through connectivity, collaboration, and networking.**

METRO GROUP IS ONE OF THE WORLD'S LEADING international retailing groups with operations in 2,200 locations across 30 countries. Our corporate philosophy is summed up by the brand message "METRO Group—The Spirit of Commerce." We are decisively reshaping the international world of retailing through our commitment to new and emerging technologies.

As a retailer, we share the same goals as our suppliers: to fulfil the requirements of our customers and to meet their expectations. To achieve this goal, we have to understand how we can best connect the demand side—the customer—with the supply side. This means we must ask ourselves whether we understand the individual processes in the supply chain: who has which responsibilities, and who needs to trigger which activities at which points in time to make the supply chain work effectively and guarantee a seamless flow of product and information.

This knowledge is a basic prerequisite. Obviously, we have suppliers at certain sites who possess the organisational and intellectual capacity to understand this, and who work closely with us to improve supply-chain processes. For many small and medium-sized suppliers, however, we carry the burden of helping them become more efficient and productive in the supply chain.

METRO Group closed 2005 with over €55.7 billion product turnover. We have some 200 large international suppliers, but the majority of our suppliers are small and medium-sized, local operations

in product categories such as dairy, bakery, meat and vegetables. Because they are locally oriented, these suppliers have limited know-how about global initiatives and activities that could improve their supply chain.

As in any business, the 80:20 rule applies perfectly to our supplier structure—the majority of volume is sourced from the major suppliers. But this does not necessarily mean that the majority of the process and workload are associated with the big suppliers. The challenge is to raise the small and medium-sized suppliers to the level of the big ones. Otherwise, we have an optimal structure for only part of our supply chain. We must work with smaller suppliers—some of whom still manage their supply chain manually—to simplify and accelerate their supply chain through new technology.

**As a retailer, we share the same goals as our suppliers: to fulfil the requirements of our customers and to meet their expectations. To achieve this goal, we have to understand how we can best connect the demand side—the customer—with the supply side.**

To achieve this goal, we have a clear responsibility to communicate with partners and suppliers so that they understand what we expect from them, what internal changes they must make and why those changes will benefit both them and us.

We know that small and medium-sized suppliers do not have the financial or human resources to implement the technologies needed to optimise their supply-chain process all by their own. So we have to help them by offering these kinds of technologies. A good example of this is the investment we made in our IT infrastructure to enable suppliers to connect to our network. We offer this free of charge—all suppliers need is a PC, a browser, and a software program, which can be purchased for €500.

A good example is our supplier portal, Metro Link. We built this solution to centralise our data, facilitate rapid data exchange with partners and provide real-time Web access to essential information. The only cost to suppliers is the licence they must acquire to use some of the applications. As a result, Metro Link has become a major information source and connectivity hub for our suppliers. For many companies, it is





all about gaining a better understanding of their information requirements, how to fulfil them and how to guarantee they receive the real-time data they require.

We expect our international and large suppliers to be early adopters of new technologies and business processes, and to participate in pilot tests of these technologies and processes in day-to-day operations. But we also are prepared to invest in infrastructure to enable our small and medium-sized suppliers to attain the same level of connectivity enjoyed by our larger suppliers.

There are a number of excellent suppliers who, from both a technology and collaborative standpoint, are well organised and prepared to support the supply-chain optimisation process. We have learned that one of our best partners in testing new business processes and technologies is P&G. Kraft Foods is another good example, as is Nestlé. Surprisingly, the bulk of this testing is done with fast-moving consumer goods (FMCG) companies. Our experience shows that it is difficult to get top-class consumer electronics companies to participate. For example, they usually lag far behind regarding adoption of electronic data records relating to data pools, or in their approach to the collaborative process. It is, therefore, a long process to get non-FMCG suppliers on board.

**We expect our international and large suppliers to be early adopters of new technologies and business processes, and to participate in pilot tests of these technologies and processes in day-to-day operations. But we also are prepared to invest in infrastructure to enable our small and medium-sized suppliers to attain the same level of connectivity enjoyed by our larger suppliers.**

Every time we want to try something new, therefore, we typically end up testing it with one of the three aforementioned suppliers, because they are organised, qualified and sufficiently resourced in terms of manpower and funding. In addition, they fully subscribe to our vision of networking and collaboration within the industry. Once a project is successful with one of these partners, we usually start to roll out the technology throughout the whole organisation.

Improving the supply chain is about collaboration and partnership. It is not our role to put significant pressure on suppliers to change their individual environments. Instead, we try to convince suppliers to incorporate new technologies, standardize innovations, adopt business process optimisation, and so on, within their own supply chain "upstream." This discussion usually occurs when it comes to business cases. Talks typically start at the door of the manufacturer's distribution centre and go downstream to the retail-store level, moving upstream from the manufacturer's distribution centre into its production facility, and on to the raw material suppliers. We have the "downstream" part in order, and want to keep it under our control. The upstream part, however, is where suppliers must now concentrate—and we encourage them to do so.

**It is not our role to put significant pressure on suppliers to change their individual environments.**

METRO Group is one of the world's first retailers to introduce Radio Frequency Identification (RFID) technology along the entire supply chain. The rollout began in November 2004, involving over 40 suppliers as well as selected warehouses and stores of the Metro Cash & Carry, Real, and Galeria Kaufhof sales divisions of METRO Group. Additional stores and suppliers in Germany will be added in the future. Our RFID rollout focuses on automation of processes for incoming and outgoing merchandise and on warehouse management. Initially, logistical units (pallets, packages, and shipments of hanging merchandise) and retail units (cartons, for example) are equipped with RFID transponders.

We did not begin with a complete RFID vision—it evolved as we learned more about the technology and how it could benefit certain business processes. Once we understood this, we tried to envisage how we might be using this technology 15 years from now. We expect that RFID will have a tremendously positive impact on our business.

Our starting point is applying RFID on the logistics side—to pallets, for example. Thanks to RFID, it is now possible to seamlessly trace the route of a product, from its manufacturer to the store shelf. This accelerates processes, helps to reduce inventories and lowers costs —to the benefit of manufacturers, retailers and customers.





We included distribution centres in the RFID roll-out so that we run the merchandising through either direct delivery from the manufacturer to the store or a distribution centre to the store. In this way, we gained an understanding of how the process works, including how to apply RFID tags effectively to pallets and how to deal with physical problems we encountered when using tags with glass, metal and certain liquids.

The retail industry has some reservations about RFID. To overcome these, we held two RFID summits for our key suppliers. We openly discussed existing problems with the technology, and explained our roll-out plans and vision. The response was very positive. We hope our experience will open the door for others within the industry to "join the club" and support us.

Aside from our involvement with specific technologies, we are also active in driving international standards and business-process optimisation within retailing through our membership in the Global Commerce Initiative Board as well as the EPCglobal board and the GS 1 board. As we become more international, and in order to control the different business formats that exist within our various business units, we need much better networking and collaboration with our suppliers and service providers. In addition, we require standardisation of data and business processes.

**Often, it appears that IT service providers are more concerned with protecting their own property than with implementing standards that could benefit the whole industry.**

A good example of one such standardisation initiative is the bar code. In the past, the U.S. used 12-digit barcodes, while Europe (13 digits) and Asia employed other standards. If manufacturers sold their products globally, they needed several different barcodes for their packaging. We have helped move the industry toward a single global standard—the 14-digit barcode. The next big challenge is making the EPC code a global standard. Standards and networks are vital prerequisites for efficient, collaborative supply-chain optimisation.

People, rather than technology, present the biggest obstacle to supply-chain optimisation. A lack of both vision and entrepreneurial spirit in top management levels of retailing and manufacturing is a major

issue affecting modernisation of the retail industry. For example, if you talk about global data standardisation, only a relative few top executives have a real understanding of what this will mean for the industry and the supply chain.

**Our starting point is applying RFID on the logistics side—to pallets, for example thanks to RFID, it is now possible to seamlessly trace the route of a product, from its manufacturer to the store shelf…**

Another major obstacle is the pervasive pressure we all face to justify capital investment, with an emphasis on proving a return on investment (ROI) within a short payback period. Take chip cards, for example. There is a view that technology still may not be advanced enough to fulfil all requirements for chip cards, and, for that reason, people tend to lean back and say, "Let's wait, then." But this attitude is not beneficial to the industry.

Most of the people in our industry agree that this technology should be implemented, and that if we can achieve this connectivity, we will all benefit from a seamless flow of information and merchandise through the supply chain—without manual intervention. There would be tremendous cost savings for the whole industry. But short-term focus on ROI is a problem generally in today's business world; it has created a climate in which long-term visions and a certain level of entrepreneurship are very difficult to find.

ROI is not just about technology, then. Over the past 15 years or so, we have learned that the creation of technology usually occurs much faster than the adoption of business processes to enable efficient use of that technology.

Look at the adoption of data warehousing technology to support complex business processes, where millions of transactions and a tremendous amount of data have to be analysed. Data warehousing was not possible 10 years ago, but is easily done today. At the same time, however, we have seen our people struggle to understand how to use technology—not because the technology is complex, but because they now must think in a more qualified way about their business processes and business in general. The technology will provide intelligent outcomes only if organisations ask the right questions first.





Understanding, therefore, is a fundamental issue for all of us. That is why I believe there is a role for technical service providers to become more involved in the improvement of supply-chain processes. First, they should communicate their overall vision more effectively. Second, they should start to build standards into their applications and be more prepared to use an open-sourced application structure. Often, it appears that IT service providers are more concerned with protecting their own property than with implementing standards that could benefit the whole industry.

It would be extremely useful if, say, enterprise architecture standards—and later, EPC and business process standards—were reflected in an application's setup. This would automatically help drive companies toward standardised business projects.

It is clear that there is a big difference between technology companies and the rest of the business world. Maybe it is the nature of their business; they are much more advanced in using tools to improve both connectivity and their internal and external business policies. We can all learn from them.

**ZYGMUNT MIERDORF**

MEMBER OF THE MANAGEMENT BOARD, METRO GROUP, GERMANY

Zygmunt Mierdorf is a member of the management board and chief information officer of the METRO Group, where he is responsible for the company's IT, e-business, human resources, logistics, and real estate divisions. In June 2004, the British magazine *Retail Week* named Mierdorf "Best IT retail professional" of the year. He is also an adviser for several different sales lines. He joined the METRO Group in 1991 and held several executive positions before becoming a member of the management board in 1999. Prior to joining the METRO Group, he was administrative managing director at Betrix Cosmetics; group chief financial officer and chairman at LRE Inc. Group; and chief financial officer at Black & Decker, Germany.

WE HAVE FOUND that the new plant can take over production of a new model in just six weeks, when it used to require up to six months.

**Tadao Takahashi**
EXECUTIVE VICE PRESIDENT, MANUFACTURING AND SUPPLY CHAIN,
NISSAN MOTOR CO., LTD., JAPAN

# Nissan manufacturing: back in the black

***Kaizen*, a Japanese concept which means continuous improvement, is the heart of Nissan Motor's manufacturing control system and strategy which employ connectivity to increase quality on the production floor.**

AFTER DIFFICULT TIMES IN THE LATE 1990s, Nissan Motor Co., Ltd., Japan's second largest auto manufacturer, is back in the black and thriving. Under the expert hand of CEO Carlos Ghosn, Nissan has achieved financial recovery by closing inefficient factories—curbing purchasing costs drastically—sharing operations with Renault, and introducing hot new products. The results are compelling—the company is enjoying solid growth, having one of its best financial results ever, and is realizing one of the highest returns in the auto industry. The company's latest N180 plan targets sales of an additional 1 million vehicles every year, with an increased global footprint—notably in China. The new plan presents a new challenge for Nissan's manufacturing teams.

### Nissan's manufacturing control system

Nissan has developed a manufacturing control system that allows us to identify a problem immediately, assess delays, and analyze the cause. In addition to Japan, we have installed this system in Canton, Mississippi and in Smyrna, Tennessee, and are planning to use it soon in the United Kingdom. Before long, I should be able to monitor what is happening everywhere, centrally from my office.

### Nissan's manufacturing objectives

At Nissan Manufacturing, our objective is to improve lead times, quality, and cost. We focus on improving the entire process, from product development to start of production. The main aims are to

connect operators on the floor and engineers in design centers; to facilitate continuous feedback from and to the plants; to capture *kaizen* opportunities across our various locations; and, ultimately, to introduce *kaizen* to other plants.

Of course, we were already exchanging data and information, but now we are also starting to share pictures, videos, and even digitized simulations of our standard manufacturing lines. For example, for *Genba Kanri* (a system that usually translates to "shop-floor management," which essentially means that problems are solved and improvements are made at the actual place where they arise: on the shop floor), we are currently changing our traditional training systems, which are based mainly on paper manuals, to Web-based document-sharing and training systems integrated with our digitized simulation models. Operators can now learn how to assemble parts and check quality by simply visualizing pictures and process steps studied and developed through our computer simulations.

**The key features of our manufacturing systems are flexibility, short lead time, and integration with our partners (suppliers).**

Previously, paper manuals made it difficult to achieve the benefits of *kaizen* on a global scale. Audit teams used to visit multiple plants across Asia, America, and Europe to identify best practices, but their findings needed to be reviewed and officially approved. It was slow, expensive, and inefficient as people often were not prepared to adopt these practices.

We practice *kaizen* everywhere in the world, but until now it has been difficult to have a clear, consolidated view of what is going on in the United States, the United Kingdom, or Japan. Now, by sharing this information over the company's intranet, everybody can adopt improvements introduced elsewhere. I encourage cross-fertilization to happen naturally through a Web-based environment where each plant can approach another plant directly, rather than information always being passed down from above.

### Nissan's connected manufacturing strategy

We are currently introducing the Nissan Integrated Manufacturing System, which will provide us with a flexible, standardized global





production system. Given Nissan's ambitious growth objectives and the global volatility of the car market, we need lean facilities and no overcapacity. If demand in the United States increases or shifts, we need to adapt our U.S. plants accordingly, with limited capacity and improved quality. Large-capacity flexibility is easy; small-capacity flexibility is the challenge.

By standardizing our assembly lines, connecting with distant robot systems through the Nissan global backbone wide-area network, and by remotely supplying data developed in our Zama, Japan prototype center, Nissan can reconfigure machines to add a new model to the production line. Whenever this system is in place—not all plants are standardized yet—we have found that the new plant can take over production of a new model in just six weeks, when it used to require up to six months. In a world where we are introducing 10 new models a year and growing our annual sales by 1 million vehicles, the power of distributed and standardized manufacturing is key to our flexibility—and to our ability to deliver and adapt to ever-changing customer needs across the globe.

### Using connectivity to improve quality on the production floor

Our manufacturing system, the Nissan Production Way (NPW), shows the direction of our mind-set and the actual activities for manufacturing on a global basis. Based on a "humane and environment-friendly" ethos, we have two distinctive concepts that serve as the basis for the NPW:

- Continuous *douki* (synchronization) with our customer needs
- Continuous quest to identify problems and enact solutions

Through these concepts, we try to achieve a manufacturing state that can cope with both customer and company needs. We call this *douki-seisan* (synchronized production), through which we seek total optimization of all stakeholders, including customers, suppliers, and ourselves.

Flexibility, short lead time, and integration with our suppliers are the key features of our manufacturing system. Quality is of utmost importance, especially in launch periods when new products are introduced. In Japan, our experts reduce the time it takes to reach a solution by remotely accessing information on quality deficiencies in

real time, quickly analyzing the root causes, and identifying their source by connecting to our information networks. We cannot yet fully realize this potential on a global basis, but it is our intention to pursue this in the near future. Going forward, we will mix "live" and remote support. We will continue to dispatch a number of experts for the start of production to the United States, China, and other locations, and at the same time we will also be able to monitor problems remotely from Japan and provide relevant advice.

We currently have two Web-based systems. The first is a body shop equipment management system that can monitor equipment in one place. Shop supervisors can see the status of all shop equipment and quickly take the required action. In Japan, the same production-operation support system has been introduced in all domestic plants. The operation information of all lines is automatically collected from each line's programmable logic control device through SCADA (supervisory control and data acquisition) and sent to a Web server, which is connected to Nissan's intranet via the database. This effective system, SCADA, uniquely developed by Nissan, makes it possible for us to obtain real-time line operation information at any time from each PC connected to Nissan's intranet. At the same time, the system allows anyone to analyze line operations easily. This system is used mainly by our manufacturing, maintenance, and engineering sections, as well as by our facilities design and process-design teams.

**In Japan, our experts reduce the time it takes to reach a solution by remotely accessing information on quality deficiencies in real time, quickly analyzing the root causes and identifying their source by connecting to our information networks.**

Using this system, we can instantly identify problems, find bottlenecks, and analyze faults. Therefore, we make full use of it in real time to practice daily *kaizen* and stabilization of production capability. This system has already been introduced to Nissan plants in Canton, Smyrna, Spain, the United Kingdom, and Mexico. We now can see what is happening on any line in any Nissan plant around the world, while sitting in any office. In addition to line operation information, database technology, production operation, and facility control know-how (such





as inspection planning, methods, recording, and trouble-shooting) are shared globally to accelerate the realization of constant and seamless production (*douki-seisan*).

The second Web-based system we use is a vehicle-quality information system that enables us to share information on quality—both upstream and downstream of the manufacturing process—and to take action quickly.

In the future, Nissan will build on its achievements and on the concepts of NPW and *kaizen* to introduce other information-sharing systems, with the goal of achieving *douki-seisan* on a global basis.

**TADAO TAKAHASHI**

EXECUTIVE VICE PRESIDENT, MANUFACTURING AND SUPPLY CHAIN,
NISSAN MOTOR CO., LTD., JAPAN

Tadao Takahashi has been a member of the Nissan board of directors and executive vice president of manufacturing (vehicle and powertrain), supply-chain management Cost Reduction Promotion Office, and industrial machinery/marine since June 2002. He joined Nissan in 1968 after graduating from the University of Tokyo and held various managerial posts in production control and engineering, before becoming a member of the board of directors in 1998 where he was in charge of the Yokohama, Fuji, Oppama, Tochigi, and Iwaki plants and Production Control, NPW Promotion, Logistics, and Overseas KD Production departments. In 1999 he was senior vice president in charge of the Manufacturing and Industrial Engineering Division for the Oppama, Murayama, Tochigi, and Kyushu Plants, as well as general manager of the Manufacturing and Industrial Engineering Division.

In 2001, Takahashi became senior vice president in charge of the Manufacturing and Industrial Engineering division of the Oppama, Tochigi (excluding Powertrain Operations Division), and Kyushu plants. He was also general manager of the Manufacturing and Industrial division, and chairman of Nissan Casting Australia Pty., Ltd.

THERE'S A TRUE OPPORTUNITY in sharing information with our suppliers and empowering them to take action.

**Michel Gornet**
EXECUTIVE VICE PRESIDENT, MANUFACTURING, RENAULT S.A., FRANCE

# Manufacturing is the heart of our business

**INFORMATION TECHNOLOGY HAS A CRITICAL ROLE TO PLAY within Renault's business—both in relation to manufacturing and in the day-to-day management and development of the business. Car manufacturers are assemblers of complex and diversified objects, so flow management is at the heart of what we do. The flow of manufacturing information is indispensable to aligning delivery of components and parts simultaneously. The more this data flow is consistent with the physical flow, the better.**

## Opportunities for connected manufacturing

AT RENAULT, WE INTERCONNECTED INFORMATION SYSTEMS (parts nomenclature, product compositions, sourcing, and so on) with physical operations a long time ago. We're in a business where everything is real-time and interdependent, so we need to know which colour of paint needs to be sprayed on a car the very second it passes in front of the painting booth. On the manufacturing floor, the value of new technologies and the Internet is not really in the production act itself. Small PCs have indeed replaced large, automated control chassis—sequential automats were replaced by programmable automats—which themselves were eventually replaced by computers. Although IT brings more flexibility, lower costs, and more effectiveness in the manufacturing process, the real breakthrough of information technology is in the plant-floor supply chain. Indeed, numerous pieces of information are now exchanged on the plant floor, and Internet technologies are far more reliable and faster than any other technology.

There are a number of significant opportunities for connected manufacturing. The supply chain is, clearly, one of the greatest. Car manufacturer supply-chain systems are extremely complex and require the right part at the right instant, in the right place, for a considerable

variety of parts and manufacturing steps. Moreover, as build-to-order takes further prevalence with shorter and shorter lead times, information systems need to be evermore adaptive. So connected manufacturing is all about managing flows of information as much as it is about inventory management.

Improving manufacturing technology and assets is another area of opportunity—by having more machine intelligence, the ability to capture and understand what's happening on the plant floor and machines that can self-analyse root causes, you can radically reduce the number of breakdowns. Given the size, complexity, and variety of current car offerings, it is an illusion to believe that we can keep in stock all the required parts and components, and replenish them to cope with a more volatile and diverse consumer demand. Lean manufacturing and just-in-time processes are the only way to manage diversity, so Renault is compelled to supply these flows with a certain degree of control, made all the more easy when connected with powerful and performing information systems. I must admit, however, that we still have some progress to make in that area.

**The real breakthrough of information technology is in the plant-floor supply chain.**

To assemble a car in a typical factory, you start with stamping—a discrete process where metal sheets are formed. For convenience, as these sheets are cumbersome, this process typically occurs on the same site as the assembly line, but it could be located elsewhere. Then comes the assembly line—a chain of successive steps starting with welding of the floor, the under body, and the sides of the vehicle, which will be gradually assembled through successive operations, from one building to the other, until the car is driven out of the factory. All along the process, the car goes through very different technical operations: body assembly, robot welding, some hand-fitting, paint preparation, the application of protective coatings and the actual paint job. Then all components necessary to finish the vehicle are assembled: seating, dashboards, engine and tyres are installed along the conveyor. At the end of the process, the vehicle is ready to be tested before being delivered to a Renault auto dealer. Today, apart from the stamping, the line is no longer dedicated to one single model like the Modus. The Modus is produced on the same line as other models. We know how to adapt existing assembly lines and painting booths to new models.





### The rise of information networks

Considerable changes in the manufacturing process over the past decade have been driven by the shift to just-in-time manufacturing. The biggest revolution, however, is the emergence of information networks with everyone connected to a common intranet. From their desks, operation unit managers can now monitor their operations, access all the relevant supply-chain information (in-bound parts as well as stock-outs) and manage all personnel administrative tasks. All this didn't exist 10 years ago. These tools opened up the operation silos; information is now shared across discrete operations, and managers can personalise their portals.

In 1999, Renault launched an ambitious programme redefining and redeploying the Renault production system (SPR). The experience of Nissan—with whom we are collaborating to boost performance—in leading-edge production systems played a key role in this initiative. The objective of the SPR was to bring the Renault group to world-class levels of performance with two fundamental principles: total quality management and lean manufacturing. SPR was meant to enhance the management and control of each basic unit of work. The implementation of these principles and the operating rules of the SPR led to a new distribution of the roles and missions of the entire hierarchical line in Renault's manufacturing.

In the early stages of deployment to the plant floor, the complexity of desktop solutions was highlighted as the greatest time-improvement opportunity for heads of basic units of work (a basic unit of work, or BUW, is a cell of 20 people—the first level where one finds a supervisor). Cross-functional teams were created with more than 100 people coming from factories around the world with support from headquarters. Their goal was to define by scope of activity (quality, cost, flow, time, resource performance, personnel management, environment, safety) a reference set of activities and solutions for each BUW desktop (specific indicators, information, data and activities to fulfil the mission). Special attention was given to defining an action-oriented, understandable, common vocabulary, giving up the arcane vocabulary developed by IT. So, for example, "to open application X" was replaced by "checking the performance of the working units." At a technical level, the company intranet, called Déclic, brought the infrastructure needed to push a set of services to access information.

Three main intranet services were retained for Renault manufacturing: a comprehensive BUW dashboard, a customisable data-access tool and dynamic links to online files and directories. The comprehensive dashboard page displays all the relevant indicators of the BUW—including hourly production, quality levels, monthly budget, order status update and maintenance status. The customisable data access tool gives one-click access to multiple data such as production schedules, in-process production, quality defect declaration and online training registration. Finally, dynamic links give one-click access to files and directories, such as nonconformity forms and personnel planning, accessible over the Renault global intranet. This was rolled out in more than 14 plants in Europe, and will roll out to the rest of the world within the next two years.

**The alliance's evolving IP communications platform is making it easy for people to talk and work together more effectively across both companies.**

Adoption of the portal has been extensive, and all users are extremely happy and satisfied. Anticipated productivity gains have been achieved with up to a 25 per cent reduction in administration time and savings of up to 30 minutes per day. In a way, the plant is taking advantage of connectivity more than the office. In some instances, machines communicate with maintenance personnel and call for maintenance in case of breakdown.

### The Renault–Nissan collaboration

The success of this strategy has depended on a close working alliance between Renault and Nissan. To share leading practices, the two companies established Renault-Nissan Information Services (RNIS), in July 2002, to deliver cost-effective systems and optimised infrastructure for the two groups' IS/IT departments. RNIS serves as a global repository of core IT competencies that both companies can use to benefit the alliance—and is a much faster solution than creating such a facility within each company. The alliance was created to help both Renault and Nissan identify ways to align processes in two organisations with different cultures, languages, histories and time zones. The expectation is that employees in every function within both companies will learn to use online collaboration tools to transform the way they work.





Another joint company, Renault-Nissan Purchasing Organisation, is also part of the strategic plan. It was created in 2001 to manage 30 per cent of the total annual purchasing of Renault and Nissan with online systems. By 2002, that total increased to 43 per cent—an annual purchasing volume of US$21.5 billion. The alliance's evolving IP communications platforms are making it easy for people to talk and work together more effectively across both companies. Together, Renault and Nissan have been able to launch between seven and 10 new products since 2002, and this pace is continuing—thanks to highly efficient IS/IT systems. Today, engineers from both companies can work together from distant parts of the world through the communication tools and connections that are now in place. The master plan is to increase velocity—to step up the speed of design, engineering, manufacturing, and retail.

### The future

Looking to the future, we have identified a number of quick wins. These include remote maintenance and video quality checks. Over and beyond that, however, it's hard to predict how manufacturing will look in 10 years' time. At one point, we asked a team of young professionals "to dream and invent the plant of the future," but we didn't come up with as much as we hoped for. I do believe, however, that our next-generation manufacturing will connect our plant with our suppliers via the Internet on a collaborative hub. There's a true opportunity in sharing information with our suppliers and empowering them to take action. Our production systems can do that today, but we haven't implemented it yet.

**MICHEL GORNET**

EXECUTIVE VICE PRESIDENT, MANUFACTURING, RENAULT S.A., FRANCE

Michel Gornet is executive vice president of manufacturing and a member of the Renault Group Executive Committee. He is a graduate of the Ecole Polytechnique engineering school, in France, and of the Harvard Business School. Gornet joined Renault in 1968 at the Billancourt plant's Powertrain Manufacturing department. In 1971 he was assigned to the manufacturing department's Unisurf project. Gornet was appointed head of the production department's Programs Unit in 1975 and became head of the B.I.W/Paint department at the Flins plant in 1979. In 1983 he joined the personnel department with the Employee Forward Planning Unit. Gornet was appointed general manager of the Billancourt plant in 1986, then general manager of the SanBUWville plant in 1989. He became director of body assembly in 1992, then senior vice president, manufacturing, in 1994, when he joined the Renault Management Committee.

ONE OF THE MOST SIGNIFICANT TRANSFORMATIONS in the past decade has been the growth of the Internet and its immediate impact on global connectivity.

**Sujeet Chand**
CHIEF TECHNICAL OFFICER AND SENIOR VICE PRESIDENT, ADVANCED TECHNOLOGY, ROCKWELL AUTOMATION INC., UNITED STATES

# Benefitting from global supply-chain integration

**SUJEET CHAND of Rockwell Automation shows that the only way to stay competitive is to drive productivity and quality throughout the enterprise with highly connected systems.**

THE GLOBAL ECONOMY and an increasingly competitive business environment are driving companies around the world to focus on how to maximize the productivity of their manufacturing plants. We believe that the only way an organization can achieve this—and, ultimately, stay competitive—is to drive productivity and quality throughout the enterprise with highly connected systems.

Within businesses, there is already widespread acknowledgement that a connection between business systems—such as enterprise resource planning (ERP)—and manufacturing plants is required to drive plant efficiency and asset utilization. And, there is a strong belief that manufacturing companies should be able to access real-time information on their plants from anywhere, at any time, to compare efficiency and quality measurements. Meanwhile, among consumers, demand is growing for greater visibility of plant-floor data—for example, the ability to track the status of your order for a new Dell computer down to exactly where that computer is in terms of assembly and shipping.

We still have a way to go before this degree of visibility is as commonplace as, say, tracking a package shipped by Federal Express or UPS. But the business world is moving toward this type of visibility as we move toward increasingly customized products and connected enterprises (see Figure 1).

Rockwell Automation is a global provider of power, control, and information solutions for industrial automation. With a focus on automation solutions that help customers meet productivity objectives,

**Framework for optimized manufacturing**

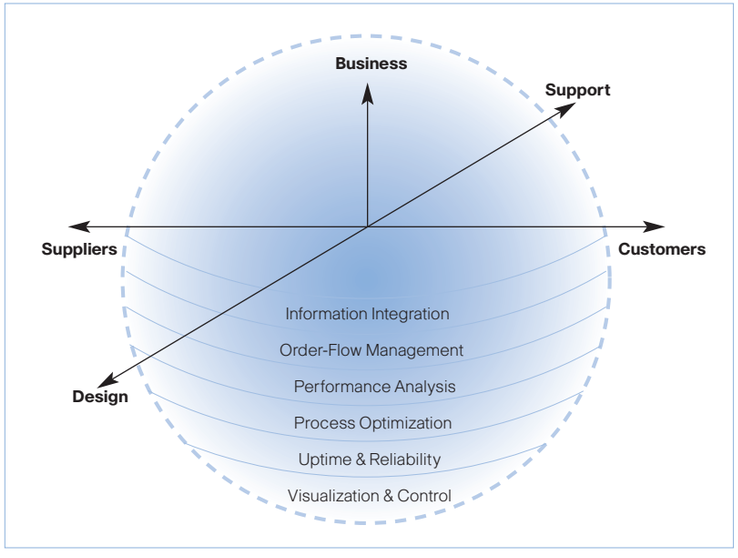


Figure 1 Rockwell Automation Inc., used with permission.

we bring together leading brands in industrial automation, including Allen-Bradley, Dodge, Reliance Electric, and Rockwell Software. Global technical and customer service is an integral part of Rockwell Automation, with nearly 5,600 distributors, system integrators, and agents serving customers in 80 countries. Rockwell Automation employs about 21,000 people worldwide with annual sales of US$4.4 billion. The company is financially and strategically focused on helping manufacturers use plant operations as a competitive advantage, to reduce costs, conserve resources, improve productivity, and reduce the time to market for material goods and services.

### The evolution from point-to-point connections to networked systems

Over the past decade, we have watched closely as industrial automation has evolved from point-to-point connections to networked systems. And, we have seen five major trends drive greater connectivity within industrial automation.

The first of these trends is supply-chain integration. Efficient management of inventories and other supply-chain operations requires





connectivity between factories and business systems, such as ERP software.

The second trend is productivity and quality. This trend has to do with getting more out of capital investment in factories by helping to ensure that manufacturing plants are highly efficient and that they are producing high-quality products at a high turnover rate. Today, very few customers are able to pull up a dashboard of metrics and compare plants globally. So driving productivity from assets is critical.

The third trend is growing regulatory compliance requirements and the satisfying of mandates. Regulatory requirements, such as the 21 CFR Part 11 federal regulations for electronic batch records from the U.S. Food and Drug Administration, require factory operations and data to be electronically collected, linked, and logged securely.

The fourth trend is safety and security, which have become extremely important—especially because of open networks on the factory floor and the fact that factories are increasingly connected to higher-level systems that allow an external person to come in and take a look at what is going on inside the factory.

**Over the past decade we have watched closely as industrial automation has evolved from point-to-point connections to networked systems.**

The fifth trend focuses on flexible manufacturing. Flexibility is becoming more important today. Whereas in the past, a manufacturing line would be designed to produce the same part, widget, or component repeatedly for a long period of time—change now occurs much more rapidly. Take the food industry, for example, where manufacturers would like to create customized packages—one style of packaging for Wal-Mart, another for Tesco—to give their products a unique identity on retailers' shelves. And in the pharmaceutical industry, drug companies are moving toward manufacturing customized medications and dosages by individual. This requires considerable flexibility in the manufacturing line, although flexibility is already increasing as a result of the global move toward mass customization.

These five trends are driving increasing levels of connectivity not just on the factory floor, but also between the factory floor and the business systems. Already, best practices are clearly evident in the responses companies are making to each trend.

**Kraft totally connected manufacturing vision**

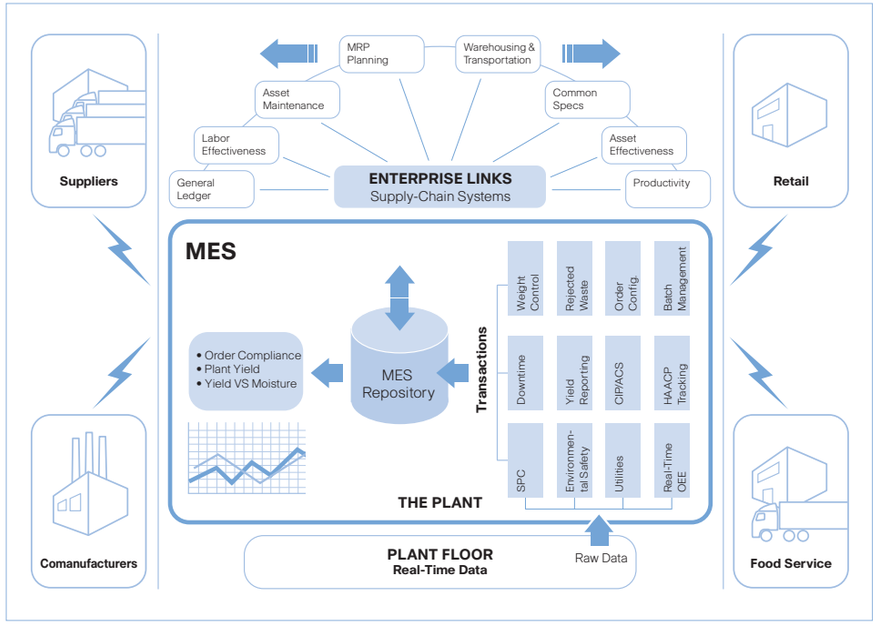


Figure 2 Rockwell Automation Inc., used with permission.

### Best practices: integration

Kraft Foods provides a good example of best practices in integration. Kraft's vision is to be a totally connected company that links the plant floor through collaborative manufacturing management to the enterprise level, as well as to retail, food service, suppliers, and comanufacturers (see Figure 2). Rockwell Automation has had a strategic supplier alliance with Kraft for many years. This relationship has evolved to provide significant levels of services and solutions, with more defined goals for connecting the factory-floor data to business systems.

We have worked with Kraft to link its plant-floor manufacturing automation investment with its front-office automation investment. So Kraft is now able to access real-time information about its plants globally, providing the ability to analyze the performance of different lines within the plants, along with efficiency, quality measures, and so on. The company uses a large amount of Rockwell automation equipment mixed with legacy equipment and offerings from other vendors. Our role has been to take data from the automation, or factory, level and elevate it to the next level using Ethernet, or whatever network is available.





In a simplified view of an integrated factory, we can identify three distinct hierarchical layers. The lowest level is the factory, or automation, layer. Above that is the manufacturing execution system (MES) layer. The top layer is the ERP system. So to go from factory data to ERP data, you need to pass through the MES layer, which features solutions for compliance, tracking and tracing, quality monitoring, maintenance, and diagnostics. Kraft's use of the MES layer clearly demonstrates best practices in integration.

Kraft's first pilot involved three plants and 64 production lines, linking collaborative manufacturing with modules for production reporting with Lot IDs, vendor-managed replenishment, overall equipment effectiveness (OEE) and downtime, weight control, and decision support. Kraft monitored the savings, which were categorized by line efficiency, standard loss allowance, labor, raw material yield, overweight product, and miscellaneous expenses, from 1995 to 1997. The savings realized were more than $1.6 million, leading Kraft to conclude that collaborative manufacturing management drives asset reliability improvements, which enable many other initiatives.

**Our role has been to take data from the automation, or factory, level and elevate it to the next level using Ethernet, or whatever network is available.**

Kraft recently completed the implementation of OEE at 48 plants in North America, covering almost 500 manufacturing lines. Partnering with Kraft for this OEE rollout, Rockwell Automation set up implementation teams across North America to assess the current infrastructure and equipment, modify the central design to each line, and implement the design, all without taking any line down during installation.

Over the next two years, Kraft and Rockwell Automation plan to roll out full operator OEE to existing capacity-limited base OEE lines, make enhancements to the existing OEE applications, enhance the financial reporting, and increase the payback through additional training. Kraft's collaborative manufacturing development group, meanwhile, is currently developing additional financial reporting to add to all of their reports.

**Collaborative manufacturing overview**

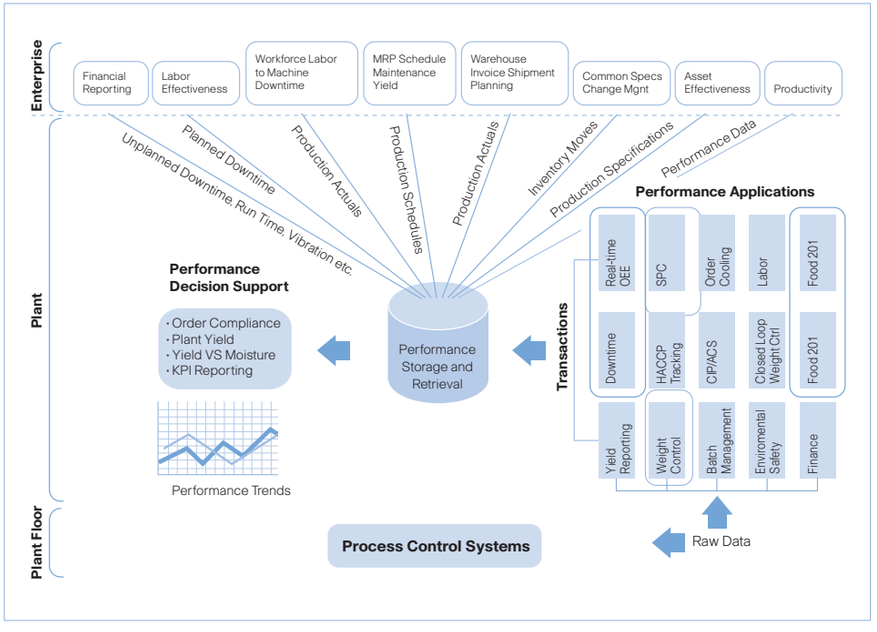


Figure 3 Rockwell Automation Inc., used with permission.

## How companies should use connectivity

Looking at connectivity in a factory environment today, we note that a typical factory will have several networks (see Figure 3). At the lowest level, there are one or more networks for connecting sensors and actuators, which are designed for real-time performance. Such networks must be deterministic, and that is where networks, such as DeviceNet and Foundation Fieldbus, fit in. These sort of networks are not designed to move a lot of traffic—for example, multimedia data such as video messages. Instead, the networks connect to a controller that bridges the information over to an information network, such as Ethernet.

We see Ethernet as the fastest-growing network in industrial automation. It is one of several communication networks we support; the other primary ones are DeviceNet and ControlNet. We utilize a common, open application protocol called the common industrial protocol, which allows easy bridging between multiple networks that support this protocol. It is open technology—we are a strong proponent of open networks and interoperability—and it has been a successful strategy because it aligns well with our customers' needs.





Rockwell Automation also supports Ethernet as a low-level control network. There is, however, a cost performance trade-off. We are not concerned about the determinism or performance of Ethernet because we have learned through laboratory trials that we can achieve adequate real-time performance by appropriately architecting Ethernet segments. The cost per node of a bit-level network is significantly less today than the cost of an Ethernet node. But that is going to change. As the number of Ethernet nodes increases, the cost will continue to come down and Ethernet connectivity will be built into processing engines that can be bought from Intel or other vendors. We are following that trend and support Ethernet IP solutions so that if a customer wants to use it for real-time control, we will implement it.

We see Ethernet as the fastest-growing network in industrial automation.

Ethernet is rapidly becoming the network of choice for the exchange of "higher-level" data or information in industrial automation. Over time, Ethernet will also support the functionality of specialized networks on the factory floor, such as safe networks for safety applications. In the near future, Ethernet and the emerging worldwide Web standards, such as Web services, will greatly influence the connectivity of the factory floor to business systems.

## Connectivity: Business Benefits

Estimating the tangible business benefits of connectivity between the factory and business systems is extremely important. Within Rockwell Automation, we use our ERP system to drive the efficiency and productivity of our factories and business operations to increasingly higher levels. The immediate paybacks are in better inventory and raw material management. Both come through improving the efficiency of the supply chain and being able to process customer orders and log what they want on a daily basis. All of this data gets placed in a single repository and is connected; whereas, in the past this data was available piecemeal, making it difficult to link all these different pieces of data.

The gap between the IT world and the factory-floor controls is a fundamental problem that exists today. This gap exists because the factory control does not talk the same language as IT systems. Factory-floor people and IT people are coming together more and more. No one

can afford the luxury of a "silo mentality" any more. In the past, I rarely saw IT people on the factory floor. But today, many factory-floor automation decisions also involve an IT person because many of our customers no longer separate IT from factory-floor investments.

**In the near future, Ethernet and the emerging worldwide Web standards, such as Web services, will greatly influence the connectivity of the factory floor to business systems.**

In the late 1990s, much investment was placed in the IT area—installing ERP, bandwidth, and infrastructure. Now it's payback time. That's where the MES layer and our FactoryTalk architecture fit in. We provide common services, such as uniform access to factory data and integrated security. Software applications can use these common services to access and integrate factory-floor data, and then write it to databases such as Oracle or SQL, which IT systems are well versed at supporting. Also, we provide a software framework for integrating legacy applications and data. So we can take the data from the factory floor and move it into the domain of IT almost seamlessly. By using the intermediate MES layer to keep this architecture open, you can continue to expand the amount of data moving from the factory to the IT world.

A customer who makes car seats for minivans is an example of using the MES layer to establish connectivity between the factory floor and ERP. This customer needed to track and trace all of the components that go into the car seat—using identifiers, such as bar codes or radio frequency identification (RFID) tags, on different components—before the car seats were assembled. Although the number of seats made each day varied depending on customer demand, having the manufacturing data connected to the ERP system allowed for daily adjustments on the factory floor.

So now the company's ERP system receives the production quota (from customers) daily and comes up with a schedule for the manufacturing line to produce that exact number of seats. This happens automatically, and when these seats are manufactured and shipped to an automotive company for incorporation into a vehicle, linkage between the vehicle ID number and seat ID number is established. If there is a problem with a car seat in a minivan, it can be traced all the way back to the car-seat manufacturer, and that manufacturer can identify every component in the seat and when it was made.





It is important to manage the expectations of such integration between factory automation and ERP. Implementing an ERP system and connecting it to manufacturing is not like flipping a switch. You cannot just put a multimillion-dollar investment into ERP software and instantly switch everything over to the new ERP system. You have to start small with selected applications—picking those that are not the most challenging—as early pilots. The focus should be on building an architecture that allows you to expand. By retaining control over a gradual rollout, you can expand in stages to include integration of performance measures, maintenance, and asset management solutions. And this, in turn, leads to flexible manufacturing and integration—it can just keep building from there. This brings me to technologies, such as RFID and wireless communications, which introduce a new level of integration and exciting new ways of creating visibility across the manufacturing value chain.

### Radio Frequency Identification Tags

RFID is one of a number of identifiers that can be used to deliver a high degree of detailed tracking. While not a new technology, RFID has recently become a hot topic with manufacturers, particularly companies in the consumer segment. Global companies, such as Wal-Mart, Tesco, Marks and Spencer, and Nokia, are implementing certain aspects of RFID. Meanwhile several industry groups, are driving their own requirements, affecting manufacturers and suppliers alike.

The potential benefits to large suppliers deploying RFID on a wide scale across the supply network are now well documented. Across the industry, companies with better demand forecast accuracy also have 15 percent less inventory, a 17 percent improvement in order ratings, and 35 percent shorter cash-to-cash cycle times than their peers.

RFID efforts aimed at inventory visibility across the supply chain are closely tied to the control systems and execution processes driving production. Control systems that drive manufacturing execution need to be modified to fully realize the proposed benefits of RFID. Retooling manufacturing assets, revamping execution strategies, recalibrating plant-level information systems, and integrating new RFID-enabled manufacturing data into enterprise systems will be critical for synchronizing the plant floor with the RFID-enabled supply chain. Full-scale RFID deployment and its impact on manufacturers, suppliers, and consumers may potentially take several years, depending on existing and developed technology and return on investment (ROI) projections in the early adoption stage.

Rockwell Automation is not obliged to use RFID tagging on its products; we do not directly supply the retail or defense communities, so our products do not come under any mandates. To assist our customers with their RFID implementations, and also to use this technology for improving our own distribution operations, we decided to conduct an RFID pilot.

A year ago, we began to tag a selected number of individual product items (rather than cases or pallets). We tagged individual printed circuit boards at one of our factories before shipping to our distribution center in Champaign, Illinois. We changed the inventory software in our Champaign distribution center to start working with RFID. In addition, we started collecting metrics and data, and gained experience in what it means to implement RFID in our own facility before we went out to assist our customers in implementing the technology. This project activity included the use of RFID technology in parallel with existing bar-coding methods, integration of RFID information with existing databases, and reliability studies that included tag and reader selection.

This RFID pilot also included a business case analysis that assessed business process changes related to quality and verification procedures, and the future impact on annual labor costs, labor force counts, order cycle times, and order throughput associated with the RFID implementation. The analysis illustrated a significant benefit—a 70-percent reduction in quality loop reworks.

**Today, many companies are deploying wireless technology in factory automation for applications where it's difficult to run wire—overhead cranes, for example.**

This means that when we ship the product to a customer, we successfully match the product to the customer order. We have a highly automated distribution center with boxes that move to different stations, and operators drop in different pieces of product based on what a customer ordered. When the box goes to the packaging point where the product is packaged and shipped, we do a scan using RFID and pick out exactly what is in the box and match it to the customer order, verify that it is the right set of products that the customer ordered, and ship it. So the quality loop rework at the very end of the line was





reduced by 70 percent. We also showed improved inventory control, and we are hoping to get about 17-percent reduction in labor costs.

We believe RFID is going to start moving back from the distribution centers into the factory. The reason is simple: you get a significantly higher ROI when you tag your case, pallet, or product in the factory. Tagging at the factory helps ensure the association of all of your manufacturing data with the RFID tag, and the same tag also can be used for tracking the object(s) in the factory. The power of RFID comes from making RFID a common key to information—from the birth of the product to its sale and eventually to its disposal.

### Wireless technology for connectivity

Another growing trend in industrial automation is wireless technologies. For example, at a major consumer goods plant in Europe, we recently implemented a wireless solution for automated guided vehicles (AGVs) to move product from one place to another, and to communicate with a central controller. This was all done with wireless communications because AGVs are mobile.

Today, many companies are deploying wireless technology in factory automation for applications where it is difficult to run wire, such as overhead cranes, for example. Signal reliability and security are two important attributes for use of wireless networks in factories. Another enabler for widespread deployment of wireless technology is a power source that is not a battery; you cannot just install 1,000 wireless sensors and tell the plant-floor personnel to replace batteries periodically on every sensor—it is just not logistically feasible.

So we are actively researching ways to power wireless radios automatically. If we can power a radio by using robots in a factory—using equipment that moves, "parasitic power"—we believe this will kick-start widespread use of wireless sensors. We are conducting a joint experiment with British Petroleum for which we placed energy-scavenging wireless sensor networks on a BP tanker for collecting diagnostics information. We are working today to drive the rollout of wireless by eliminating the need for a battery, and to help ensure reliability and security.

In addition to wireless, we also are looking at power-line technologies—power-line communications—as an alternative because power lines do run throughout a factory. Power-line technologies could be an alternative to wire-reduction technologies which, of course, is what wireless is.

### Manufacturing growth in the Far East is driving greater global connectivity

A future challenge—and impetus—for connectivity of industrial automation systems, however, comes not from developed Western markets, but from territories that are increasingly taking on global manufacturing capacity—China, for example, or other countries in Asia-Pacific or eastern Europe.

Our observation has been that although factories in China may adopt a labor-intensive approach initially to take advantage of cheaper labor, China continues to lead the world in lost manufacturing jobs year after year. China eliminated 15 percent of its manufacturing workforce in 2003, not due to lack of investment or because factories aren't being built, but because there is greater automation and more productivity in China's factories.

This is a positive trend, and we see significant growth of our business in China. It is a vibrant region in terms of finding places to apply automation technologies. Many multinational companies are incorporating modern infrastructure into the plants they're building in China, and this will continue to accelerate—just as it did in industrialized countries, except at a much faster pace. So China will most likely miss the growing pains of the industrial revolution we experienced when we went from highly manual plants to automation slowly over time.

**If you're building plants anywhere in the world, you've got to build state-of-the-art facilities that are compatible with global standards and produce the same quality of product as any other part of the world.**

Global competitiveness will continue to be the driving factor for the growth of manufacturing in China. If companies can produce the same product somewhere else at a significantly lower cost while maintaining quality, they'll go there. Otherwise, they will lose their competitive edge. To maintain quality when moving production to another part of the world, you must have the same—if not greater—level of automation.





The U.S. Federal Drug Administration is not going to relax its guidelines for products made in China; the same guidelines, quality levels, and checks and balances will apply to products made anywhere in the world. Wal-Mart is not going to excuse Chinese manufacturers from placing RFID tags on their cases and pallets. So a Chinese plant cannot be built in isolation from what is happening in global technology trends. If you are building plants anywhere in the world, you have to build state-of-the-art facilities that are compatible with global standards and produce the same quality of product as any other part of the world.

### Summary

It is amazing how quickly things can change. One of the most significant transformations in the past decade has been the growth of the Internet and its immediate impact on global connectivity. Industrial automation is benefiting from this change through the adoption of Ethernet and worldwide Web technologies for greater interoperability and connectivity. The global economy is driving greater distribution of manufacturing and logistics operations, and the only way to stay competitive is to drive productivity and quality throughout the enterprise through highly connected systems.

**SUJEET CHAND**

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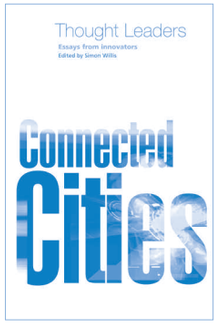


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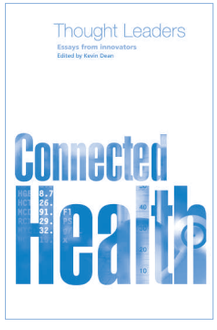


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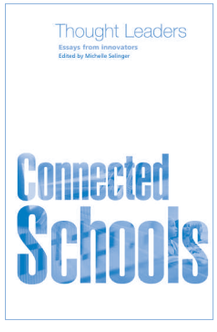


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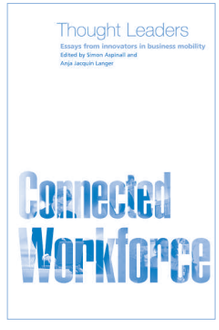


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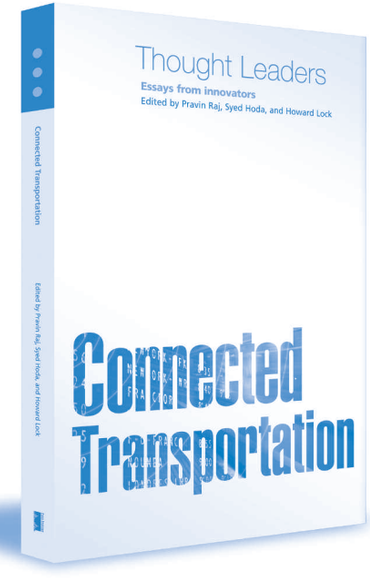


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