

Global Products: Change and Complexity

2.1 Change

Understanding the opportunities and potential problems of global products, and then developing appropriate responses, is not as easy as it looks. A good way to start is by trying to understand the product environment. This is a useful first step towards overcoming the problems and taking advantage of the opportunities.

Among the reasons for the difficulty of getting the required understanding are the high levels of complexity and change in the global product environment.

A lot of companies would be happy if there were no changes anywhere in the world in the product environment. They could then organise themselves, as well as possible, to provide customers, as efficiently as possible, the same product day after day, year after year. They would not need new products and, over time, would probably be able to eliminate many of the problems with existing products. They could plan exactly how many products to produce and sell. Everyone would be happy. There would be no need for anything to change. As the global population increased, market sizes would increase. As companies went down the experience curve, they would reduce costs and increase profits.

However, the situation in the twenty-first century isn't anything like that. The world environment for manufactured products has changed a lot over the last ten years, and the changed environment continues to change.

As an example of the real world, one company that I work with now renews about 75% of its products each year. It's a medium-sized company in the food industry. Of the 300 or so products it had in 2005, only about 70 were taken forward into 2006. Of the 300 products in the 2006 product range, more than 200 were newly developed. Compared to ten years ago, another company I work with has operations in 20 more countries than before. That gives the company lots more opportunities, but each new country has brought new challenges.

Among the changes that companies face are increased complexity, globalisation, geopolitical developments, social and health issues, changing business models, improved telecommunications, transport and travel, new technologies, new IS applications, new company structures, new customer requirements, changes to products, shareholder influences, financial market influences, regulation, deregulation, environmental concerns and sustainable development issues (Figure 2.1 and Figure 2.2). In such an environment, it's best to have a clear understanding of objectives and capabilities, otherwise the result can be disastrous.

- Globalisation
- Outsourcing, multi-site activities
- Corporate restructuring
- Multi-cultural, multi-lingual environments
- Increasing product/solution/service complexity
- Shareholder demands to increase value
- Mass customisation and personalisation
- Mobile communications
- Product traceability
- Sustainable Development
- Recycling directives
- Evolution and complexity of information systems
- Collaborative product development
- Process focus and reengineering
- Toolbox Information Systems
- Large volumes of data

Figure 2.1. Some challenges facing product companies

2.2 Complexity

Not only are companies affected by many different changes, but the changes are often intertwined. As a result, the product environment is becoming increasingly complex with many interwoven components and numerous interdependencies being affected by many overlapping changes. The resulting environment is so complex that it is often difficult to see what the changes are, and what is really driving them, or to understand how they will affect a particular company and a particular product (Figure 2.3).

Among the changes, some create opportunities, some create problems, some lead to the need to change, some are the source of more changes. The resulting changes can also be a source of change. Unexpected events resulting from changes can be a source of further change. All these changes snowball, making it difficult to know how to respond.

In addition, changes have associated risks, and changes in one area may lead to enhanced risks in another area. If the risks were only related to one component or

change in the environment, it might be easy to manage them. Unfortunately though, they are often related to many changes, making their management difficult.

- Improved communications
- Improved supply chain
- Open Source software
- World Wide Web and Internet
- Product lifecycle focus
- Product development performance
- Parallel world of software development
- Effective product innovation
- Products with very long lives
- Knowledge Management
- Retirement of knowledge workers
- Regulatory requirements
- Accidents
- Multiple versions of processes
- High cost of training new employees

Figure 2.2. More challenges facing product companies

2.3 Globalisation

Globalisation can have many effects on a company, even a small one. One positive effect is that, because of globalisation, it now has the opportunity to sell its products and services worldwide. It has the opportunity to find many new customers and increase sales. Another effect of globalisation is that even small and medium-sized companies now have competitors all over the world. And they may find that these competitors bring out similar products, but with better cost/performance than their own models. The increased competition means companies have to be more innovative, develop better products, develop them faster and develop them at lower cost. Globalisation also implies companies have to be close to customers in many places, and understand customer requirements and sell products in many environments. A presence in many countries may be necessary. However, the situation in different countries is different. Companies have to take account of these differences. They have to get pricing right in many different environments. They also have to provide technical information, parts, products and service in many locations – and meet regulations in many countries. They have to coordinate the launch of new and modified products for the global marketplace.

Globalisation is a change that has affected many products. The word ‘globalisation’ describes the increasing economic interdependence of countries. Harvard professor Theodore Levitt used it in 1983 in an article called ‘Globalization of Markets’. In the 1990s, globalisation became noticeable well beyond academic circles. A wave of imports from low-cost countries led to the price of goods dropping in advanced industrial countries. Globalisation isn’t

something that happened with a single ‘Big Bang’. If it had, it might be easier to address because everything would have changed – and then everything would have settled down. Instead, globalisation is an on-going long-term process, with new effects continuing to appear and nobody being sure what will happen next.

Often the changes described in this chapter may be seen as reasons for change or as effects of change. For example, ‘increased competition’ could be seen as a reason or an effect. For a particular company, increased competition may be seen as an effect of globalisation. However, for that company, increased competition may also be seen as a reason for changing the way it operates.

2.4 Geopolitical Developments

Geopolitical changes, for example those resulting from the end of the Soviet Union, affect the product environment. The end of the Cold War led to many countries taking different roles in the global economy. For example, in 2005, more than half of Poland’s exports went to Western Europe. In 2005, more than 20% of China’s exports went to the US.

Political change in China, and its high availability of low-cost workers, have led to investment by foreign companies and the emergence of China as a large market for consumer and capital goods, a major manufacturing country and a major exporter of manufactured goods. For example, the leading steel-producing countries worldwide in 2005 were China (about 350 million metric tons), followed by Japan (about 100). China’s use of steel rose from about 120 mmt in 1999 to over 300 mmt in 2005.

Russia has become a leading producer of oil and gas, second only to Saudi Arabia in oil production, and the world leader in gas reserves. Russia’s Gazprom had sales over \$30 billion in 2004. In early 2007, only Exxon Mobil and General Electric had larger market capitalisations than Gazprom. In 2006, there were nearly as many billionaires in Moscow as in New York.

India has emerged as a leading producer of software, software developers and IS companies. For example, Infosys, headquartered in Bangalore, has become a global IT solutions company with revenues over \$2 billion in 2006.

The end of the Cold War enabled many countries that were in the Warsaw Pact to withdraw and join the European Union. By January 2007, the European Union had expanded to include 27 countries, with an internal market of about 487 million people.

The population of China is over 1.3 billion, that of India more than 1 billion. More than 900 million people live on the continent of Africa. Indonesia, Brazil, Pakistan, Russia, Bangladesh, Nigeria, Japan and Mexico all have populations of more than 100 million. These key future markets provide the opportunity of a lot of

customers for some providers of global products, although many of the countries appear to be in faraway locations.

2.5 Social and Health Problems

Perhaps it would be easier to provide global products if so many potential customers weren't so far away. Perhaps it would be easier to sell global products if so many people didn't live in poverty. In 1999, according to Human Development Reports from the United Nations Development Programme, 2.8 billion people lived on less than \$2 a day and 1.2 billion lived on less than \$1 a day.

And, in the West, the rich are getting richer, the poor are getting poorer and the middle classes are becoming relatively poorer. The situation is similar in many ways to that at the end of the nineteenth century and the beginning of the twentieth century, with beggars on the streets of many Western capitals.

The world population is expected to rise from 6.3 billion in 2002 to 9 billion in 2050. Worldwide, the average age is expected to increase by over 50% by 2050. By then, it is expected there will be more people over 60 than under 14. As the world's population grows and ages, the demand for healthcare will increase. In 2006, more than 11% of Germany's GDP was spent on health, and the percentage is expected to grow. Population ageing will lead to a demand for new types of products in areas such as medical equipment, home help robots, pharmaceutical drugs, replacement body parts and geriatric cosmetics.

More people now live in cities than in rural areas. As the world's population grows, and even more people move to cities, the need for decent housing will increase. In 2000, about a billion people lived in slums, but according to current trends, the number will rise to 3.5 billion by 2050. An opportunity for providers of homes and home products.

AIDS was first recognised in 1981. In 1983, its cause, the HIV retrovirus, was identified. It led to a new market for pharmaceuticals. It's estimated that, in the most affected countries, there will be 46 million excess deaths because of AIDS in the first decade of the twenty-first century. According to an UNAIDS report, 38.6 million people worldwide suffered from HIV in 2005. Many of these people live on less than \$1 a day, and can't afford high-cost pharmaceutical drugs. An opportunity for providers of low-cost drugs.

2.6 Changing Business Models

The changing environment provides opportunities for new business models to be developed, making life difficult for companies with more traditional models.

Some companies no longer manufacture their products, but outsource all production so that they can concentrate on product marketing, development and sales. Suppliers may bid for outsourced work at an online auction.

Some companies lease their equipment and facilities rather than purchase them.

Some companies offer their products for lease rather than for purchase. Aircraft, trains and cars can be leased. Some software is offered on a pay-for-use basis over the Web rather than for purchase.

Some companies offer guaranteed product performance. They guarantee that their products will run for a certain number of hours per month, or that a certain percentage of products will still be in service after 10 years.

Some companies cut out the traditional sales force by only selling over the Web. Others allow customers to set the price they will pay for a product at an online auction.

Some companies offer products free over the Web, with their income coming from Web advertising.

Low-cost product and service providers often cut out non-essential functions, and get customers to carry out some activities themselves, or to pay for them separately.

Fast-food eateries eat into the restaurant market by offering reduced choice, standard menus and no waiter service. Other companies compete by providing ready-to-eat food and drink products that are sold in shops for customers to eat on the street or next to you on public transport.

Some pharmaceutical companies focus on providing low-cost generics that have the same effect as existing high-cost brand-name drugs.

New microfinance institutions are emerging, such as Grameen Bank, founded by Muhammad Yunus. Their products have billions of potential customers.

Non-governmental organisations and non-profit foundations are starting to develop and produce products, and own their intellectual property, to ensure that products can get to the billions of people in the world who can't afford the prices demanded by multi-nationals based in high-cost countries.

2.7 Improved Travel, Transport and Telecommunications

Improved travel services offer the opportunity to be closer to customers and suppliers in faraway locations.

Improved freight services ease part and product transport, providing the opportunity to be closer to customers and suppliers in faraway locations.

Improved telecommunications offer the opportunity to interact closely with customers and suppliers without being in the same room.

2.8 Revolutionary New Technologies

New technologies have appeared and caused such massive change that they are frequently referred to as revolutions – the Digital Revolution, the Electronics Revolution, the Computer Revolution, the Communication Revolution, the Biotechnology Revolution, the Internet Revolution, *etc.*

Each one of these revolutions leads to change and opportunities. For example, mobile telephony has provided a variety of opportunities to carry out activities in new ways. Billions of text (SMS — Short Message Service) messages are sent each day. Service workers can connect to a central database from the customer site where they are working. On-the-move patients involved in trials of new drugs can send performance data rapidly to researchers. Designers of fashion goods can travel worldwide, yet be creative and deliver new designs within minutes of their conception.

2.9 New IS Applications

In recent years, many new Information Systems have been brought to market. They have provided companies the opportunity to work more effectively internally, and, externally, to get closer to customers, suppliers and partners.

Application systems have evolved. More and more of the activities related to product marketing, development, sales and support have been automated. The cost of functionality has dropped. Applications with functionality that used to sell for hundreds of thousands of dollars now sell for hundreds of dollars.

Database management systems have evolved to manage product data distributed on multiple sites in different countries around the world.

New applications are often implemented as Islands of Automation that are not closely integrated with other applications. Many are not interoperable with existing applications. Often they duplicate or triplicate the functionality of existing applications. Often they have separate databases, duplicating information that is already in other databases and raising questions as to where the “master” is. Time is lost, and errors introduced, as information is transferred manually from one application to another.

Once an application has been implemented in a company to address a particular requirement, it tends to expand and be used to address other activities of the product environment. This on-going expansion of applications raises questions for IS Departments (CIO organisations) as to which applications they should provide to support the company’s activities.

Enterprise-wide solutions are becoming ever more complex and time-consuming to implement. These solutions can be so complex that no single vendor can supply all components – leading to numerous partnerships among application

vendors and system integrators. Many implementations of enterprise-wide IS solutions fail – some surveys claim failure rates as high as 50%. Increasingly, many small and medium manufacturing companies don't have the in-house resources to implement such complex enterprise-wide systems, so outsource these activities.

IS applications used in R&D, engineering and product development are often developed to address the widest possible market. They tend to be “toolboxes”, rich in technical functions and features, but not focused on the specific needs of a particular company or industry. This approach helps minimise their cost, but results in the need for each company to work out how best to use them in their particular industry environment.

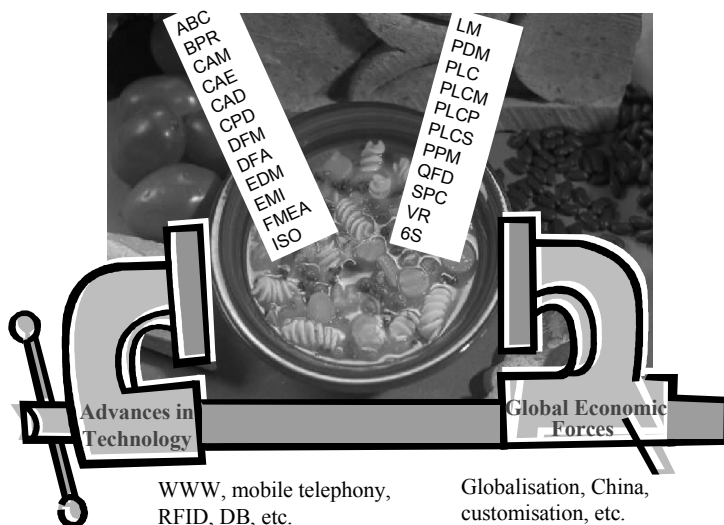


Figure 2.3. More pressure on the product environment

The Web and the Internet have provided the basic technology to allow many activities to be carried out faster and/or at lower cost. They enable information to be transferred faster. For example, engineering drawings can now be sent by e-mail or over the Web, instead of by post. Product requirements can be collected through questionnaires on the Web. Cars and other products can be configured and ordered on the Web. Development data in a Web-based project workspace can be shared between workers on several sites. Developers at different locations can review product designs together. Maintenance staff working on customer sites can get product data over the Web. New Web-based sales channels (B2C, B2B, trading exchanges, *etc.*) remove waste from the supply chain and get products to customers faster. Web-based developments are often relatively simple to implement, and provide companies with new opportunities. However, due to the freedom provided by the Web and the Internet, it is not easy for companies to manage the use of such functionality. It can be difficult to make sure that information remains coherent,

and that competitors are not able to break in and browse through confidential know-how, looking for new ideas and gaps to exploit.

With new IS applications, more products are modelled and analysed, more information is developed about product models, and more analysis and simulation is carried out. As a result, the volume of product definition and product-related data that is generated is enormous. Whereas developers once thought in terms of megabytes of data, they now think more of gigabytes – and organisations think in terms of terabytes (10^{12} bytes), petabytes and exabytes (10^{18} bytes) of data. The high volume of data is needed to develop better products, but it also increases the difficulty of managing and keeping control of data. When applications are upgraded, it is often difficult to know exactly which data does not need to be transferred to the new application, so all the data is transferred, including that which is not needed. Moves towards the “Paperless Office” often have the opposite effect to that intended, with each worker creating an unofficial and poorly managed archive of thousands of pages of paper-based information.

As IS applications and databases have evolved, the value that users try to draw from data has increased. Information is more valuable than data, knowledge more valuable than information. Companies want to make sure that the data that is entered into computers can be easily and correctly interpreted, and is available as knowledge.

2.10 New Company Structures

Company structures have changed in response to the changing environment. Many products are now the result of the concerted effort of an Extended Enterprise made up of a manufacturer and a chain of suppliers. The automotive industry has been accustomed for decades to these chains of car manufacturer, Tier 1 supplier, Tier 2 supplier, Tier 3 supplier, *etc.* The concept became widespread in the electronics industry in the 1990s. In the aircraft industry, Boeing adopted it at the beginning of the twenty-first century for the 787 Dreamliner. The concept is now found in most other industries.

In the automotive industry, parts and products are developed round the world. As an example, in 2006, Ford Motor Company gave Gold and Silver World Excellence Awards to 45 global suppliers for exemplary performance in 2005. Among the award winners were companies from Australia, Brasil, Canada, China, Denmark, France, Germany, India, Japan, Korea, Mexico, South Africa, Spain, Taiwan, Turkey, the UK and the US.

A few years ago, suppliers of parts and components used to be referred to as Original Equipment Manufacturers (OEM), as they were the original manufacturers of the equipment included by another company in its products. In recent years the meaning has changed, and the company that incorporates parts and components from suppliers is now referred to as the OEM. Many OEMs put in place different chains for different products, or even for different product

derivatives. Participants in the chain may be located in different time zones, with different business processes and different application systems. The long, widely dispersed chain necessitates better planning and control, better communications and well-defined business processes and information use.

In the early 1990s, globalisation led to imports from low-cost countries causing the price of goods in industrialised countries to drop. In response, companies in industrialised countries reduced their costs by outsourcing production to low-cost countries. In addition to outsourcing of production, companies then started outsourcing product development and service. Outsourcing provides the opportunity for a company to focus its efforts on the activities it considers most important and/or provide its competitive advantage, while getting other companies to carry out activities it considers less important. The companies it outsources to can usually do these activities either better or at lower cost. In other cases, the outsourcing company may not even have the resources to carry out these activities.

Outsourcing modifies a company's flow of information and materials — leading to the need to realign processes and applications. Product development and support activities are complex and difficult to control even when they are in one company and on one site. When they are spread over many companies in many locations, their complexity increases, as does the danger of loss of control. Outsourcing has led to long design, supply and support chains with the result that product development, manufacturing and support activities are spread out over different organisations, often over different continents. Managing them when they were in one company in one location was difficult enough, managing them across an extended enterprise is many times more difficult.

Since the mid-1990s, many development and manufacturing organisations have moved away from the model of a single R&D or Product Engineering department in one location. For various reasons, they found this was not the most effective approach. In particular, companies have found that research is often carried out faster by small organisations operating without the overheads and bureaucracy of large organisations. As a result, in some cases, a company's researchers and developers are now located in several places round the world. In some companies, much of the R&D work is outsourced to suppliers. In others, research is carried out through partnerships with other companies. Carrying out research on multiple sites offers an opportunity to bring new products to market faster. However, relocating R&D activities changes the organisation of work.

Although the Extended Enterprise may sometimes appear as a convenient way for large companies to reduce headcount and increase shareholder returns, it also provides small and medium companies with the opportunity to increase their sales and to grow their profits. Initially, a small company may just supply one component to a large company. Later it can develop and produce more components for that company, supply it in more regions, and then supply similar products to other large companies. It can also move from supplying individual components to supplying sub-assemblies and assemblies.

Skilled professionals are sought by companies regardless of their nationality or culture. Their diverse skills are seen as an opportunity by companies looking to provide innovative new products. However, as product-related tasks are increasingly carried out by people from different countries working on different sites of different companies in different countries on different continents, the potential for misunderstanding due to different understandings of words, phrases, processes and behaviour increases. Translation increases costs, and the result may not convey 100% of the meaning. Product development projects can slow down as cultural differences between different sites lead to difficulties in finding common solutions.

Many of the first generation of product developers that worked with computers, and implicitly or explicitly defined their companies' information and activity structures and elements, are now reaching retiring age. Born between 1945 and 1950, these Baby Boomers were among the first users of computers at the end of the 1960s and the beginning of the 1970s. By the year 2000 they were in management positions at the heart of their companies' product environments. When they retire, they take with them the knowledge of why and how many activities in their organisations are carried out, and why particular design and other decisions were taken for specific products.

Most companies developing products have the two basic processes of New Product Development and Product Modification. The New Product Development (or New Product Introduction) process is fairly similar in every company, with the same input (requirements for a new product) and the same output (the new product). The Product Modification process is fairly similar in every company, with the same input (requirements to change an existing product) and the same output (the modified product). However, each company has developed its own processes separately, with the result that all companies have different processes. Managing a company-specific process takes a lot of effort. Implementing an IS application to support a company-specific process takes a lot of customisation effort. And, because there are no standard processes of New Product Development and Product Modification, universities and technical schools can't teach students a standard process. So when students join a company, a lot of time is wasted as they learn and understand all the details of the company's specific processes. And time is wasted when an OEM wants to work with several new suppliers, each with its own activities, applications and documents.

Increasingly, companies are offering products that contain a mixture of mechanical, electrical, electronic and software modules. They develop mechanical, electrical and electronic components in a similar way, with similar processes and applications. However, the processes and applications used for software development are generally very different. Using two separate sets of processes and applications creates all sorts of problems, and can lead to customers receiving control software that doesn't correspond to their product hardware.

Companies recognise that future profits will not come from the manufacture of commodity components and products in developed countries. Companies in countries where wage costs are 10% or 20% of those in the US will be able to carry out manufacturing activities at a much lower cost. To survive, companies in developed countries are restructuring to create revenues in other ways. They are, for example, developing ideas for new environment-friendly products, providing customised products, providing advanced products that less competent competitors can't offer, providing services to support product use and improve the customer experience, refurbishing existing products, or taking financial and environmental responsibility for products produced in low-cost countries.

Corporate cultures change frequently with some companies empowering workers to enable them to make better use of resources to meet customer requirements. Other employers offer increasingly insecure part time and flexible employment conditions leading to workforces with little knowledge or understanding of the company they work for – or its products.

2.11 New Customer Requirements

Consumers want a product that corresponds to their requirements. They don't want the standard product imagined by a marketing specialist, or a customer focus group, on another continent. This leads to increasing pressure for mass customisation — the provision at a mass production price of products and services meeting the specific requirements of individual customers. Mass customisation provides a company the opportunity to increase the number of satisfied customers. However, customised products are more difficult to develop, sell and support than standard products. For mass customisation to become a reality, processes and applications have to be adapted to meet the new requirement.

Some customers also want more services offered along with the product. Sometimes it seems as if the services are more important than the product. Developing and supporting these services often requires additional skills and is not easy for companies that only used to sell products.

There are increasing demands for product traceability from regulators and consumers to provide and assure safety. Product traceability is important in industries ranging from food and pharmaceutical to automotive and offshore. If an airbag fails, a car manufacturer wants to find all the others from the same batch as soon as possible. If an oil rig collapses, any steel parts at fault need to be identified so that similar problems can be avoided on other rigs. Organisations that can successfully track products and parts are at an advantage compared to competitors that cannot. Recalls of millions of parts, or millions of products, are very expensive, and may cost millions of dollars.

Consumer market segmentation and the prioritisation of target segments becomes more complex as the potential market becomes larger and more diverse.

The demands of New York's Baby Boomers and Generation X, as they search for a deeply satisfying connected new experience from a customised product with the latest design from a globally recognised brand, may be relatively easy to understand. But what about the need of Grey Wolves, Generation Y and the Millenium Generation for digital pets, camera phones and domestic robots in Paris, Tel Aviv, Chongqing, Tokyo, Auckland, Soweto and Mexico City?

Consumers want to identify with their sport, fashion, music and screen heroes, from wherever they come. As these activities and industries become increasingly global, brands and products also become global. Crossover products, such as the Nike+ iPod nano, or a mobile phone that is not a high-tech product but a fashion accessory, emerge, intertwining features and functionality previously only available in separate product areas.

2.12 Products

Many new products are launched each day.

The functionality of products goes on increasing, complicating their development and support. In many industries, onboard electronics and embedded software are major areas for innovation. For example, cars now have functions to help drivers find the right direction, park, steer, avoid other cars, *etc.* The value of the electronic components in a car may represent about 25% of the total value.

Products are becoming increasingly complex with more and more parts and functions. Although more complex products are proposed, they still need to be easy to operate, otherwise customers will not buy them. Cars contain more and more electronics, but are not more difficult to use. Cameras have much more functionality, but are easier to use. Since many people are unable even to operate the controller of their VCR, companies have to make products that are easy to use, even though they are actually more complex.

The support of products with very long lifetimes, such as aircraft, power stations and telephone exchanges, is complicated by the many changes in data media and formats that occur during their lifetimes. The IS applications that create this data evolve through many versions. Application vendors mature and disappear. Even the company that made a product may disappear during the product's lifetime. For example, Concorde was developed by the British Aircraft Corporation and Aerospatiale, but by the time of the Paris crash, neither of these companies existed. However, customers and regulations may require companies to produce documentation about products they, or predecessor companies, developed 50 or more years ago.

Lifetimes for some products are approaching 100 years. The B-52, for example, first flew in 1952, and is expected to fly beyond the year 2040. On the other hand, the lifetime of some products is now so short that the development of a future

generation has to start before the development of the previous generation has been finished.

Many companies now offer complete solutions, rather than individual products. This adds a new layer of challenges. Solutions are more complex to develop and support than single products. It's also more difficult to sell a solution than a product. For a product, the price and features are usually clear, and the sale often involves mainly bargaining to find an acceptable price. For a solution sale, a key step in the process is to understand the specific functions, features and performance that a potential buyer is looking for in the solution.

2.13 Shareholder Value

In the 1990s, there was a strong trend for companies to increase shareholder value and thereby appear more attractive to current and potential shareholders. The desire to increase the pay-out to shareholders usually led to pressure to reduce costs. Cost reduction was usually achieved through headcount reduction, outsourcing and offshoring in the expectation that profits would increase as costs dropped and revenues held steady. The effect on products was a secondary consideration.

2.14 Market Mentality

In the market economy, the value of anything at any particular time is defined by what a buyer is prepared to pay for it. In 2006, the market value of a barrel of oil ranged between \$44 and \$76, even though it contained exactly the same product and the same volume. Market values of other natural resources used in products – such as cocoa, steel, and platinum – are also subject to change. Between 2002 and 2005, the value of \$1 fluctuated between 0.75 euros and 1.13 euros. The continual changes in the relative values of currencies, and in the prices of raw materials and semi-finished products, make it difficult for a company to know how much it will have to pay for these in the future, and what price it should propose to customers. It can hedge the risks of changes, but this adds an additional cost to the business, and hence to the product. As hedges are hedged, and hedged hedges hedged, huge volumes of financial transactions are generated. In 2005, exports of goods and services of the 30 OECD member countries amounted to \$8.5 trillion, yet annual global currency dealings are estimated to be close to \$500 trillion.

The need for shareholders and traders to know the value of a company as precisely as possible leads to companies producing their financial results within a few weeks of the end of the financial quarter. If the company has failed to meet its guidance on earnings, the stock price may drop sharply in a few minutes. To avoid this, a lot of effort goes into setting up a company's systems to collect and manage financial data as effectively as possible. A lot of management time goes into working on the figures to ensure they meet market expectations. A Stock Exchange mentality can develop, with managers more interested in quarterly results than in

the long-term well-being of their products and services. The rewards for getting the figures right have greatly increased in recent years. According to the Economic Policy Institute's report, "The State of Working America 2006/2007", in 2005, U.S. CEOs of major companies earned 262 times more than an average worker. In 1965, U.S. CEOs in major companies earned 24 times more than an average worker.

Within companies, with financial figures being so important, product-related activities have been getting increasingly low priority. The main focus of most business managers is now the financial processes and the money flowing through them. Rightly so, some would say, since without positive cash flow, nobody will be paid for long – and workers will lose their jobs. Second priority goes to the sales process, which produces money from customers in the short term. Then come the production processes, as customers often won't actually part with their hard-earned money, or their hard-earned credit, until they are sure the product exists. As for product development, this has a much lower priority. Unless products can be developed in a few weeks, the financial results of product development will be long-term, and not apparent on the top line, or the bottom line, in the next quarterly report. In the rear are the product support activities.

Financial markets want transparency about a company and its products so that investors can take decisions on the basis of full and current information. However, the company's long-term stakeholders may consider much of the information in a company, particularly about its products, to be confidential and a source of value, and will want to keep it secret. Intellectual property management becomes increasingly important at the same time as pressures rise for increased disclosure by companies.

2.15 Regulation and Deregulation

Deregulation and regulation lead to different types of changes.

In 1979, Margaret Thatcher became UK Prime Minister. Aiming to reduce the role of government and increase individual self-reliance, her programme included privatisation, deregulation, and the introduction of market mechanisms into education and health. Many of her ideas were implemented worldwide with little thought as to what they would imply for the details of product development, manufacturing and support. Deregulation led to the break-up of large organisations – often with well-defined responsibilities, but bureaucratic and inefficient behaviour, and offering poor service to customers – and their replacement by numerous companies, contractors and subcontractors with unclear relationships.

Companies in all industries are faced by an increasing number of regulatory requirements. These are often voluminous and subject to frequent change. Just managing the regulations and linking them to different products and services in different countries is a time-consuming task. Many regulations are specific to

particular industries or types of products. Others, such as those resulting from the Sarbanes-Oxley Act, have a wider scope.

Regulations lead to requirements for analysis of everything from food and beverages to cosmetics and chemicals. Regulations are often introduced with the intention of doing good for mankind. The European Union, for example, introduced the Restriction of Hazardous Substances (RoHS) directive to address use of lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls and polybrominated diphenyl ether. The EU's Waste Electrical and Electronic Equipment directive was aimed at preventing waste electrical and electronic equipment (WEEE). The EU's End of Life Vehicle directive is aimed at getting manufacturers to dispose of vehicles in an environmentally sensitive way.

In 2006, the European Commission enacted new legislation, known as Reach (Registration, Evaluation and Authorisation of Chemicals), to force companies to disclose basic data on the chemicals they produce. The long-term effect of many chemicals is unknown. CFCs (chlorofluorocarbons) were thought for many years to be safe refrigerants and solvents. In the 1970s it became clear that they create holes in the ozone layer, especially over Antarctica. Reductions in ozone levels in the upper atmosphere lead to more Ultraviolet B (UVB) getting through to the earth's surface. UVB causes nonmelanoma skin cancer and has a role in the development of malignant melanomas. In the 1930s, DDT (dichlorodiphenyltrichloroethane) was seen as a good insecticide, particularly effective against malaria-spreading mosquitoes. However, by the 1950s, problems were appearing. Many insects developed resistance to DDT, and it was found to be highly toxic for fish. DDT has a half-life of about eight years, so it stays in the body for a long time. In the early 1970s, countries such as Sweden and the US banned its use. It is now thought to be carcinogenous, and to damage the liver, the nervous system and the reproductive system.

Regulations often add costs. In 2006, the *ex-Oriskany*, a decommissioned aircraft carrier, became the largest ship intentionally sunk as an artificial reef. The US Navy spent \$13.29 million to complete the environmental preparations and scuttling in conformance with Environmental Protection Agency (EPA) guidance.

Many product recalls are due not to a problem with the product itself, but to the labelling not corresponding exactly either to the product or to the labelling regulations.

Accidents can lead to new regulations that change the environment of manufactured products. In 1989, the Exxon Valdez oil tanker struck Bligh Reef in Prince William Sound, Alaska, spilling over 10 million gallons of crude oil. In the aftermath of the accident, Congress passed the Oil Pollution Act of 1990, leading to the phase-out and replacement of single-hulled oil tankers navigating in U.S. waters by double-hulled tankers. In 1976, an explosion occurred in a reactor in a chemical plant about 20 km north of Milan, Italy. A toxic cloud of dioxin was accidentally released into the atmosphere and contaminated an area of about four

square miles. The Seveso disaster, named after the town most affected, led to many changes in regulations.

2.16 Environmental and Sustainable Development

Since the 1960s, in response to the rising recognition of the potential dangers of products and production to mankind and the planet, politicians and ecologists have influenced business behaviour, forcing companies to think about environmental issues, waste products and recycling.

As global consumption increases, supplies of oil, water, and elements such as iron, are put under pressure. There's widespread concern, for example, about the future lack of petroleum products. The world currently uses about 25 billion barrels of oil per year, and total world reserves of oil are estimated at about 1,000 billion barrels. At current consumption rates, there'll be none left in 40 years. If consumption rates remain unchanged, the increase in the world's population will result in the reserves being exhausted in just over 30 years.

In 1987, the Brundtland Commission defined Sustainable Development as development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It's a holistic concept that aims to unite economic growth, social equity, and environmental management. Sustainable development and related ecological/environment activities represent a major business opportunity. There are many product-related activities that can help achieve sustainable development targets. They include: reducing the quantity of energy and materials used in a product and in its production; reducing the quantity of energy and materials wasted; finding new ways to re-use materials; finding new ways to recycle material; improving the energy-recovery rates of incineration; improving landfill productivity. Aiming for sustainable development often implies a 90% reduction in the use of new resources for a product. Sustainable development and related activities represent a major business opportunity that can provide opportunities for faster growth and profitability through improved current products and services, and innovation of new products and services. Areas to address include improving air quality, reducing greenhouse gas emissions, enabling waste to be recycled or composted, improving the heating and insulation of homes, improving energy efficiency, implementing more efficient low carbon technologies, using renewable energy, restoring contaminated soil and groundwater, monitoring and preventing pollution, treating waste water, ensuring that housing is of a decent standard, managing energy consumption, *etc.*

In 1997 at Kyoto, Japan, delegates from all over the world agreed on the need to reduce emissions of greenhouse gases, especially carbon dioxide. A lot of these emissions come from products such as cars, aircraft and power plants driven by petroleum products. A report on the cost of global warming published in 2006 by economist Sir Nicholas Stern suggested that, if action is not taken on emissions, global warming could shrink the global economy by 20%. That would affect the sales of many global products. The report suggested 1% of global gross domestic

product should be spent on tackling climate change. That could be an opportunity for many global products.

2.17 Changing Roles

Historically, universities had roles of storing knowledge (the library), transmitting knowledge to the next generation (teaching), certifying that a student has reached a certain level, and carrying out research. Many universities have existed for centuries; the University of Bologna was founded in 1088, Harvard in 1636, William and Mary in 1696, Yale in 1701. Today, the Web provides more knowledge than a traditional library, and the best professors in the world can offer webinars to students throughout the world. Collaborative virtual classrooms, running on the Web, enable an unlimited number of students, and both human and virtual tutors. Staff and students can participate from any location. E-learning applications include course management, interactive assessment, role-playing and simulation. Students like e-learning and its ease of use, 24/7 availability, access from any location, possibilities to rerun a lecture, electronic course material, *etc.*

In many companies, there is a feeling that because they have been forced to respond quickly to global changes – or go out of business – their know-how is now years ahead of that available in many universities, where there has not been such pressure. Some large companies even set up their own ‘Universities’.

In the past, universities offered a once-in-a-lifetime teaching environment. The university staff taught the student for three years at the university. Then the student left, and usually never returned. Today, a lifelong learning environment is needed in which the student learns to learn, and then continues to learn and develop knowledge assets.

Historically, the industrial revolution brought thousands of workers together in factories. Hundreds of white-collar workers were brought together in offices. Today, as a result of the Communication and Computer Revolutions, many people work alone, or in a small group, in a “Small or Home Office (SOHO)” environment. They may be working for a large company, or as an individual, or for a small company. They need products such as portable computers and mobile telephones to be effective, and are supported by e-working tools such as email, instant messaging, video-conferencing, webinars, collaborative workspaces, communities and blogs.

2.18 Inertia

Many organisations, whether companies, public institutions or countries, suffer from inertia. For example, more than half a century ago, many countries in the West introduced a retirement age of 65 years. At the time, life expectancy wasn’t much longer. Families were large, most work was manual, and health care was basic. The cost of retirement pensions was met by monthly contributions from

workers. Even though life expectancy has increased by more than ten years since then, and birth rates have fallen, resulting in fewer young workers to fund pensions, these countries find it difficult to change the retirement age. It's difficult to get people to think differently. For example, it's not until 2029 that Germany plans to have raised the retirement age from 65 to 67.

In a start-up, or green-field company, it is much easier to introduce new technologies than in a more mature company with workers accustomed to doing things the old way. It can be difficult to teach some dogs new tricks.

2.19 Free Trade

In recent years, the World Trade Organisation was established (1995), the North American Free Trade Area, linking Canada, Mexico and the United States, was established (1994), other free trade regions have expanded, and there have been reductions in trade barriers. This helps companies to offer global products.

2.20 Communities

Internet and the World Wide Web have enabled the development of many communities. These groups of people have, and share, knowledge and experience of a particular subject. Sometimes linking thousands of people, they have collective knowledge and experience greater than that of most companies. Such resource reservoirs didn't exist in the twentieth century. They offer companies many opportunities. Companies can work with communities to find ideas for new products and processes and ways to improve existing products and processes.

2.21 Low-cost and Lean

Many manufacturing companies run programs to become leaner, reducing waste in areas such as:

- Transportation
- Inventory
- Motion
- Waiting
- Overproduction
- Non-value-adding processing (e.g. features that aren't essential)
- Defects

As a result, they can offer products at a lower price, and compete in low-cost markets with high-quality products.

Lean Manufacturing approaches are similar to low-cost approaches adopted in other industries, for example by low-cost airlines.

2.22 The Result and the Requirement

The result of the many changes mentioned above is a complex, risky, continually changing, uncertain, highly competitive, global product environment. This is characterised by demanding customers, horizontal integration across the Extended Enterprise, many small and medium companies in the design, supply and support chains, few layers of management, globalisation, mass customisation, ubiquitous computing, fast technological evolution, a focus on electronics and information, and small numbers of knowledge workers from different functions working together in collaborative teams. There's growing competitive and legislative pressure, such as that concerned with product liability, deregulation, health, safety and the environment. There are technology issues to be faced, including the effect of the increasing amount of electronics and software in products, the possibilities offered by widespread communication networks, and the rapidly decreasing cost of computer power. Multi-technologies in the product make things more complex.

To be successful in this environment, a company must be able to supply and support the products that customers require, at the time required by the customer. The company must have great products. It must have a great product deployment capability. Customer expectations are rising. With so many manufacturers proposing products, why should a customer settle for a second-rate product or late delivery? Customer demands imply better products and services, a wider product range, customisation and market niches, but there's also increasing consumer resistance to price increases. Product costs must be trimmed so that they correspond exactly to customer requirements. Product functionality must be improved to match these requirements. Customer service must be improved with on-time documentation delivery, reliable delivery times, prompt complaint handling, and easy product repairability. Products must be brought to market faster. Technology is evolving fast and products are becoming obsolete sooner. The reduced time between product launch and product retirement erodes sales revenues. As product lifetimes get shorter, significant market share is lost if a product is not brought to market at the earliest possible moment. A company that gets to market first can capitalise on late market entry by other companies.

The complex, risky, continually changing, uncertain, highly competitive, global product environment makes life difficult for companies that develop, produce and support products. In such an environment, they need to have great products that leave competitors far behind and a great product deployment capability. They need to be continually in control of their products. If they aren't, and for one reason or another, they take their eye off the ball, unpleasant consequences can occur.

2.23 The Risks of Not Meeting the Requirements

If a company loses control of its products and product-related activities, it runs several risks:

- Development projects not finishing on time
- New products not providing competitive advantage
- Products not behaving as expected
- Financial losses due to damages resulting from product use
- Damage to the company's image
- Loss of customers concerned about product problems
- Revenues lost to low-cost competitors
- Reduced profit due to costs of recalls and legal liabilities
- Resignation of top executives
- Management appearances in court

Problems with products can result in high costs. In October 2006, Sony announced details of a global voluntary replacement program for certain battery packs using Sony-manufactured lithium ion battery cells. The estimated cost to Sony, based on a potential 9.6 million battery packs, was about 51 billion yen (about \$440 million).

When, in July 2000, an Air France Concorde crashed soon after takeoff, 100 passengers and 9 crew members died. Compensation agreements are believed to have cost insurers over \$100m. Concorde was taken out of service, and although commercial flights were restarted in 2001, it was withdrawn from service in 2003. Potential ticket sales of tens of millions of dollars were lost.

In 1999, NASA's \$125 million Mars Climate Orbiter got too close to Mars and burned up in the atmosphere. The two spy satellites destroyed in November 2003 after lift-off from Tanegashima Island because of an unspecified technical failure cost an estimated 125 billion yen (about \$1 billion).

The seven-member crew died when, in 1986, the Challenger Space Shuttle was destroyed 73 seconds after launch. When, in 2003, the Columbia Space Shuttle broke up during re-entry, the seven-member crew died.

All 215 passengers and 14 crew members died when Swissair Flight 111 crashed into the Atlantic Ocean near Halifax, Nova Scotia, on September 2, 1998.

Estimates for the cost of the A380 delivery delay range up to \$6 billion. In July 2006, the EADS Board of Directors accepted the resignation of Noel Forgeard as EADS CEO, and the resignation of Gustav Humbert as Airbus CEO. In July 2006, Christian Streiff was confirmed as Airbus President and Chief Executive. In October 2006, Louis Gallois was appointed Airbus President and Chief Executive Officer.

The expected development cost of the A350 XWB is about \$10 billion, double that of the initially proposed A350.

Merck voluntarily withdrew VIOXX in September 2004. Worldwide sales in 2003 were \$2.5 billion.

The BSE crisis cost the UK more than \$4bn in slaughtered cattle, compensation and lost exports.

In 2001, as a result of high tyre failure rates, Ford Motor Company announced it would replace all 13 million Firestone Wilderness AT tyres on its vehicles. It took a charge of \$2.1 billion to cover the costs of replacing the tyres.

Global products offer companies the opportunity to have billions of customers and billions of dollars of sales revenues. However, without the right product and the right product deployment capability, the opportunity will be lost. Even worse, billions of dollars may be lost, product users may be killed, and company workers may lose their jobs.

Faced with such opportunity and risk, it may make sense for a company to have a good understanding of its product environment. The following chapter shows what can happen in the absence of such understanding.

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