Chapter 4
Emergence of PLM

4.1 Product

The word "product" has many meanings and implications in the context of PLM. There is the individual physical product that is in the hands of the customer. There are various descriptions of that product in the company or companies that develop, produce and support it. These may be on paper and/or in computers.

The individual product used by the customer may be just one of an identical batch of thousands, or it may be a unique product. The product may be a successor or a derivative of another product. It may be one of a product range or product line, and these may be parts of a product family. In turn these all make up the company's product portfolio.

The product may be made of many assemblies and thousands of parts. An assembly may also be made of a large number of parts. A part used in one assembly may be used in other assemblies. An assembly used in one product may be used in other products.

At any given time, most companies will have products in all phases of the lifecycle. The products may have been developed by the company itself. They may be under development. Or they may have been acquired as a result of merger and acquisition (M&A) activity.

The product may be a tangible product, or an intangible product, such as a software product or an insurance policy. The "product" may actually be a service.

4.2 Lifecycle

PLM is the activity of managing a product throughout its lifecycle, "from cradle to grave", "from sunrise to sunset".

There is nothing new in the concept of a lifecycle. In 1599, Shakespeare described a lifecycle when he wrote of the seven ages of man (the infant,

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schoolboy, the lover, a soldier, the justice, the lean and slippered pantaloon, second childhood).

The concept of a product having a lifecycle has existed for a long time in many industries. It's frequently found in industries where products (such as aircraft and power plants) have long lives. Yet in other industries, many companies have tended to ignore what happens to their product once it's gone out the factory gate.

Sometimes it's not very clear what is meant by the lifecycle, as manufacturers and users of products have different views of the product life and the product lifecycle.

From the Marketing viewpoint there are market-oriented lifecycles. A four-stage example is product introduction, growth, maturity and decline. A five-stage example is product development, market introduction, market growth, market maturity and sales decline. Different approaches to the product's identity, pricing and sales strategy may be taken in different stages.

Raymond Vernon of the Harvard Business School developed a four-stage international product lifecycle theory showing how a product's production location changes as the product goes through its lifecycle.

And, from the global resource viewpoint, there is an environmental product lifecycle. In this lifecycle, a natural resource (such as an ore, or oil) is extracted from the earth, the resource is processed, the processed resource is used in the manufacturing of a product, the product is used, and when the product is no longer needed, the resource/waste is managed. It may be reused, recycled or disposed of.

A user of a product may think of a product having a "life" from the moment they acquire it and start using it, to the moment they stop using it, or dispose of it (Fig. 4.1).

As seen by the user of the product, there are five phases in a product's lifecycle: imagination; definition; realisation; use; disposal (Fig. 4.2).

As seen by a manufacturer of a product, there are also five phases in a product's lifecycle: imagination; definition; realisation; support; retirement (Fig. 4.3).

The first three phases are the same for the manufacturer and the user, but the last two are different. When the user is using the product, the manufacturer will probably need to provide some kind of support. For example, a car has to be serviced. Later, for various reasons, the manufacturer will stop producing the product. Later still, it will stop supporting the product. The company "retires"

first, there's an idea for the product (such as a car). At this stage the car may just be a dream in someone's head
then the car is defined in detail. In other words an exact description is created. In this stage, the physical product, the car, doesn't exist and can't be used
then the product is "realised", for example, all the parts of the car are produced and assembled in a form in which it can be used
then the product is "used" by someone, or maybe "operated" on their behalf
and finally the product comes to the end of its life. Some parts of it may be reused, some recycled and some disposed of

Fig. 4.1 Activities in the lifecycle

the product, gradually reducing support levels, and eventually no longer providing any service.

Not only are the last two phases different for the manufacturer and the user, but there is no simple chronological relation between them. A user may stop using a product (Phase D) but the manufacturer has to continue supporting it (Phase 4) for other users. A manufacturer may retire a product (Phase 5) well before a user disposes of it (Phase E). Or a user may dispose of the product (Phase E) before the manufacturer retires it (Phase 5). Further complicating the situation, the user may dispose of the product by returning it to the manufacturer, who then recycles it. The phases seen by the user don't occur one after the other, they overlap (Fig. 4.4).

For example, while the user is using the car (Phase D), poorly performing parts may stop working and be disposed of (Phase E), and be replaced by parts that have been redesigned (Phase B) and newly manufactured (Phase C).

Another way to describe the five phases is shown in Fig. 4.5.

While this representation neatly shows where "End-of-Life" fits, it masks the different views seen by the manufacturer and the user.

In reality, what happens in the End-of-Life phase isn't very clear for many manufacturers. According to the report of the GGI 2000 Product Development Metrics Survey carried out in 2000 by the Goldense Group, Inc. (Needham, MA), only 19% of companies had an active product obsolescence or product retirement activity. In 81% of companies, old products just faded away over time as fewer and fewer orders were placed for them.

For a customer, the "product life" usually relates to the particular product they use, as in "my car is 10 years old" or "over my car's life, total emissions of carbon dioxide will be more than 50 tonnes".

Fig. 4.2 Product user's view of the lifecycle

A	B	C	D	E
Imagine	Define	Realise	Use/ Operate	Dispose/ Recycle

Fig. 4.3 Product manufacturer's view of the lifecycle

1	2	3	4	5
Imagine	Define	Realise	Support/ Service	Retire

Fig. 4.4 Overlapping lifecycle phases

A	Imagine	XXX
B	Define	XXXXXXXXXXX
C	Realise	XXXXXXXXXXXX
D	Use	XXXXX XXXXXXXXXXXXXXX
E	Dispose	XXXXXXXXXXX XXXXXXXXX

Fig. 4.5 End-of-Life view

i	ii	iii	iv	v
Imagine	Define	Realise	Useful life	End-of-Life

For a manufacturer, the "product lifetime" is usually the time period over which a particular product is produced. After this time period, a replacement product may be available. The Ford Model T had a lifetime of 18 years. It was in production from September 1908 to June 1927. It was replaced by the Ford Model A, which had a lifetime of 4 years. It was in production from October 1927 to August 1931. The Wright Model B Flyer had a lifetime of 2 years. It was produced from 1910 to 1912. The last Wright Model B flew in 1934. It had a life of more than 30 years.

An individual customer's product with a long "product life" may still be in use after it's been retired by its manufacturer.

The activities that make up the lifecycle vary from one industry to another. And their relative importance changes from one industry to another. There are many activities. They include product screening, specification, design, sourcing, costing, development, testing, release, manufacturing, packaging, operation, deployment, maintenance, refurbishment, service, decommissioning, dismantling, demolition, recycling and elimination. Whatever the industry, the activities fit into one of the five phases.

The many activities in the lifecycle enable current products and services to be produced and supported. In parallel, the product portfolio is maintained. Platform products are defined and built. Derivative products follow. Product lines, product groups, and product families are created and maintained. Plans are prepared for future products and services. Projects for new products are defined and carried out. Projects are defined and carried out to modify existing products and services.

4.3 Changing Views of Products

Years ago, nobody even thought about Product Lifecycle Management. The market for most companies was local. Customer Choice was limited, "any colour … so long as it's black". In the 1950s and 1960s, getting products to market was the main focus. What happened after that was secondary, people just wanted new products. Following on from the Second World War, those were golden decades for manufacturing industry. Demand exceeded production capability. Social trends away from rural life produced more city-dwellers. Prosperity led to new customers happy just to buy a widening range of consumer goods such as cars, washing machines, wirelesses, telephones and television sets. Factories were often vertically integrated. Most industrial goods were sold in the country where they were designed and produced. Computers were in their infancy. Development of new products was left to the engineers. At the end of their life, products went to a tip, dump, field or the sea. However, some people were beginning to ask questions about the way products were developed, and about their effects. In the late 1950s there was the thalidomide tragedy. And in 1962, Rachel Carson published "Silent Spring", warning about the use of chemical pesticides such as DDT. In 1965 Ralph Nader published "Unsafe at Any Speed: The Designed-In Dangers of the

American Automobile" and started a movement towards consumer safety. In the 1950s, Iceland became concerned that the fish stocks around its coast were being depleted by trawlers from other countries, particularly the UK. Iceland's economy was dominated by fish and fish-related activities. In 1958, it extended its fishing limits from 4 to 12 miles.

The first Numerical Control (NC) programs were written in the 1950s, the first CAD programs in the 1960s. They ran on mainframe computers. The first minicomputers, such as Digital Equipment Corporation's 12-bit PDP-8 were introduced in the early 1960s. By the early 1970s, more powerful minicomputers, such as the PDP-11, were used for CAD.

In the 1970s, the Oil Shock and Nixon's scrapping of the Bretton Woods agreement led to inflation and currency fluctuations. Companies in the West were worried by the increasing presence and quantity of high-quality, low-cost Japanese cars and electronics. They eventually responded with JIT, ISO 9000 and TQM. Computer power increased, while computer prices decreased. CAD, Computer Aided Manufacturing (CAM) and Material Requirements Planning (MRP) developed, and were used more widely in industry.

In 1973, Joseph Harrington published "Computer-Integrated Manufacturing". Someone even came up with the equation CIM = CAD + CAM + MRP + FA (Factory Automation) which gives the impression that that there's not much more to product development and manufacturing than connecting up the computers. There was no sign of the customer or product support in the equation.

During the 1970s, the development of new products was mainly carried out by young engineers. Product support was left to the older, more experienced engineers. As young engineers are often not all that interested in customer requirements, and like to work as individuals, customers received products with unwanted functionality and little support, the product developers communicating with neither the market nor the support engineers.

During this period, system development methodologies were introduced to manage software development. These methodologies divided projects into phases, and used deliverables and approvals to maintain control. In 1970, W.W. Royce published an article called "Managing the development of large software systems: concepts and techniques." This referred to the Waterfall system development methodology (requirements, analysis, design, coding, testing and maintenance). Other methodologies had different phases, for example: initial investigation; feasibility study; requirements definition; system design; coding; unit testing; integration and system testing; implementation and system maintenance.

In the 1970s, many engineering activities were carried out in series. The Engineering Department did all its work alone, then "threw the design over the wall" to the Manufacturing Department. Manufacturing found all sorts of problems with the design, and sent it back to Engineering for improvement. In the 1980s, companies started to implement Concurrent Engineering and Simultaneous Engineering methodologies to overcome the problems of serial engineering activities.

In its December 1988 report "The Role of Concurrent Engineering in Weapons System Acquisition", Concurrent Engineering was defined by the Institute for Defense Analysis (IDA) as—"… a systematic approach to the integrated, concurrent design of products and their related processes, including manufacture and support. This approach is intended to cause the developers, from the outset, to consider all elements of the product life cycle from conception through disposal, including quality, cost, schedule, and user requirements."

In the 1980s, MRP evolved to MRP2. Minicomputers gave way to workstations and PCs. Networks became increasingly powerful. CAD and CAM systems were no longer centralised. As companies started to be swamped by engineering data, the first Engineering Data Management (EDM) systems appeared.

In 1983, Theodore Levitt wrote an article called 'Globalization of Markets'. In 1987, the Brundtland Commission reported on Sustainable Development, defining it as development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

The end of the Cold War in 1991 altered the geopolitical equation, leading to major changes for the Aerospace and Defence (A&D) sector of manufacturing industry.

In the 1990s, globalisation hit. A wave of imports from low-cost countries led to the price of goods dropping in advanced industrial countries. In response, production was outsourced to low-cost countries. Then product development was outsourced.

In 1992, "Engineering Information Management Systems: Beyond CAD/CAM to Concurrent Engineering Support" was published. The link was made between CAD, management of product data, and business processes.

In 1993, Joseph Pine wrote "Mass Customization: The New Frontier of Business Competition". In 1994, Michael Hammer published "Reengineering the Corporation". Many companies started Business Process Reengineering initiatives, significantly streamlining many business activities. However, little effort went into reengineering the processes of the product lifecycle.

In the 1990s, the World Wide Web, e-commerce, B2B and trading exchanges appeared. MRP2 evolved to ERP. CAD functionality became a commodity. EDM systems were relabelled as PDM systems and brought some order to all the product data. Web-based sales configurators allowed customers all over the world to purchase the exact products they wanted.

With development outsourced to different locations, and developers needing to work closely together, Concurrent Engineering, the Web and CAD morphed into Collaborative Development. Air freight, DHL and FedEx enabled rapid transport of designs, parts and goods. A presence in other countries became necessary.

Ecologists became more vocal, questioning why more products weren't recycled, and why the production and distribution processes of manufacturing industry created so much pollution. Was the real cost of shipping parts and products being taken into account? Did it make sense for the components of your Sunday lunch to travel 50,000 miles before they got to your plate? Did it make sense for cows to be transported hundreds of miles from one place to another ten times during their

lifetime so that various subsidies could be collected? Questions were asked about the true cost of the pollution from all the planes and trucks. And how should Total Cost of Ownership and Total Cost of Use be defined?

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.

During the late 1990s, trillions of dollars were created in the dot.com boom. Banks, pension funds, insurance companies and mutual funds demonstrated their skills at investing their customers' money. The Nasdaq and the New York Stock Exchange lost about 8 trillion dollars in the crash that followed.

In 2000, the first version of the Global Reporting Initiative's (GRI) Sustainability Reporting Guidelines was released.

In December 2001, after admitting accounting errors that inflated earnings, Enron Corporation filed for bankruptcy protection. Arthur Andersen, one of the world's leading accountancy firms, was found guilty of shredding key documents. In July 2002, WorldCom filed for bankruptcy after $11 billion of accounting irregularities were uncovered. The Sarbanes–Oxley Act, signed into law in 2002, introduced harsh penalties for anyone found guilty of corporate wrong-doing.

In the early years of the new millennium, Develop Anywhere Sell Anywhere Manufacture Anywhere Support Anywhere (DASAMASA) became the aim of leading manufacturers. An example would be a car that was developed at two sites in the USA, three in Europe and two in Japan. It was sold on a Web-site in Germany to a Swede living in Australia. It was manufactured in Poland, China, Vietnam, Singapore, Mexico, Taiwan, France, Canada, the USA and Italy. It was serviced in Brazil when the Swede moved there. And it was serviced later in Mexico, where it was resold. Before finally being scrapped and recycled in California. Not just a global car. A DASAMASA car (Fig. 4.6).

In a presentation in June 2001, the President of ArvinMeritor, Inc. said, "For example, at ArvinMeritor, we manufacture a manifold for the VW Beetle that was conceived in Warton, U.K., developed and produced as components in Finnentrop, Germany. Key components are shipped, assembled and incorporated into production in our exhaust plant in Mexico. The Beetle is then sold to customers in the U.S. and Canada, and, finally, to customers back in Germany."

Fig. 4.6 Lifecycle of a DASAMASA car

Imagine	*Define*	*Realise*	*Use / Operate*	*Dispose/ Recycle*
Europe	Europe	Canada	Australia	USA
Japan	Japan	China	Brazil	
USA	USA	France	Mexico	
		Italy	USA	
		Mexico		
		Poland		
		Singapore		
		Taiwan		
		USA		
		Vietnam		

In 2007, financial markets peaked, with bankers paying themselves bonuses of tens of billions of dollars. The following year, the sub-prime crisis led to the biggest financial collapse since the 1930s. Lehman Brothers, one of the world's leading financial firms, collapsed. Bankers begged for tens of billions of dollars of state aid. In 2009, General Motors sought bankruptcy protection.

Faced with the financial crisis, it was the G20, formed in 1999, that acted, and not the G7. The G7 (Canada, France, Germany, Italy, Japan, United Kingdom, and United States) had been formed in 1976. In addition to the G7 countries, the G20 group also includes Argentina, Australia, Brazil, China, India, Indonesia, Mexico, Russia, Saudi Arabia, South Africa, South Korea, Turkey and the European Union.

Meanwhile, the tallest buildings in the world were no longer being built in the USA. The successors to the Sears Tower, Chicago (442 m, built in 1973) were Kuala Lumpur's Twin Towers (452 m, 1988), Taipei 101 (509 m, 2004) and Dubai's Burj Khalifa (828 m, 2010).

In the twenty-first century, the global economy with its uncertain rules, unanswered questions, intense competition, ever-changing consumer preferences and financial fluctuations asks a lot from companies making products. Cost, quality, revenues, shareholder value and market-share are continual concerns for CEOs. Should they look to outsource even more activities to progressively lower-cost countries, or should they keep them close to home and close to government protection and subsidies? Air freight, travel, telecommunications, video conferencing and the Web make it easy to work with people anywhere. With development, sales, manufacturing and support activities possible anywhere, how should CEOs manage functional roles and boundaries?

4.4 Emergence of PLM

Before the twenty-first century, a PLM approach wasn't sufficiently needed from a business point of view, and wasn't possible from the technical viewpoint.

PLM emerged in about 2001. Before then, companies implicitly managed products across their lifecycles. But they didn't do this, even conceptually, in an explicit, "joined-up", continuous way. Instead they managed separately department-by-department, for example, in Marketing, R&D, Manufacturing and Support. And other departments, such as IS and Quality, took product-related decisions separately. Without explicit, "joined-up", management of the products across the lifecycle, things fell through the cracks (Fig. 3.8). Even if everyone in the marketing, R&D, manufacturing and support chain had done their work correctly according to company procedures, the end result could be problems such as products getting to market late, and products not working properly in the field.

By bringing together previously disparate and fragmented activities, systems and processes, PLM helps overcome the many problems, such as these, that resulted from the old unconnected approach.

4.5 A New Paradigm

PLM is a holistic business activity addressing not only products but also organisational structure, working methods, processes, people, information structures and information systems. It's a new paradigm, a new way of looking at the world of products. (A paradigm is a conceptual structure that helps people think about a particular subject.) This new paradigm for a company's particular situation of products, market, customers, competitors and technology leads to new opportunities and new ways to organise resources to achieve benefits.

PLM manages each individual product across its lifecycle, from "cradle to grave"; from the very first idea for the product all the way through until it's retired and disposed of. Managing a product all the way across its lifecycle allows a company to take control of what happens to it.

But PLM doesn't just manage one of a company's products. It manages, in an integrated way, the parts, the products and the product portfolio. It manages the whole range, from individual part through individual product to the entire portfolio of products.

The portfolio of product development projects is the project portfolio. However it's sometimes referred to as the product portfolio. This is confusing since the term "product portfolio" is also used to refer to the company's portfolio of products.

The product development projects can be put in an Integrated Portfolio with the products, providing an overview of all products, whether developed or under development. In Fig. 4.7, Product 1 has been retired, Product 2 is no longer realised but is still supported, and Product 3 is realised and supported. Product 4 is in the definition phase, while Product 5 is in the idea phase.

4.6 Across the Lifecycle

PLM manages a company's projects to innovate and develop products, and their related services, all the way across the lifecycle. Without new products, company revenues will decline. Innovation activities are the source of growth and wealth generation in a company, and PLM makes them more effective. PLM helps a company get control of its products and services, and enables it to take responsibility for them across the lifecycle. Mastering the activities in the lifecycle makes

Fig. 4.7 An Integrated Portfolio

	Phase		*Imagine*	*Define*	*Realise*	*Support*	*Retire*
Product/Project							
1							X
2						X	
3					X	X	
4				X			
5			X				

it easier to provide reliable products, sell services on them, and even sell services on competitors' products.

PLM has a wide scope in terms of application across a company because it's used throughout the lifecycle of a product. Customer input into product design early in the lifecycle aids customer satisfaction and identifies the demand. PLM is needed at this stage, for example, to capture product requirements. Companies want to develop excellent products, so they need PLM during research and development, when they are discussing ideas and concepts, and defining the product. They need it when developing new parts and the new product, modifying existing parts, testing prototypes, introducing the new product to market, and retiring existing products. They want to sell excellent products to their customers, so they need PLM during the sales process. They want to provide excellent support to customers, so they need PLM during the use stage.

4.7 A New Way of Thinking

At first glance, PLM may just appear to address the management of products across the lifecycle. However, that's just the tip of the iceberg. PLM offers a new way of thinking about products and manufacturing industry (Fig. 4.8).

4.7.1 Thinking About Manufacturing

Before PLM, companies aimed to make a product and get it in the hands of the customer. The activities of Manufacturing and Assembly created most of the value for the company.

Before PLM	*With PLM*
Think Product Manufacturing	Think Product Lifecycle
Think vertically about the company	Think horizontal
Think functionally about the company	Think lifecycle
Think about one activity of the company	Think about several activities
Think product development	Think cradle-to-grave
Focus on the customer	Focus on the product, and then the customer
Listen to the Voice of the Customer	Listen to the Voice of the Product
Think going forward in time	Think forwards and backwards
Think Customer Survey	Think Customer Involvement
Think product portfolio & project portfolio	Think Integrated Portfolio
Think bottom-up, starting with a part	Think top-down, starting with the portfolio
Think about the product lifecycle bit-by-bit	Think about PLM in a joined-up, holistic way
Think PLM is for the techies	Think PLM is a top management issue
Think profit	Think profit and planet
Think ourProcesses	Think standard processes
Think ourData	Think standard information
Think ourApplications	Think standard applications

Fig. 4.8 Before PLM and with PLM

Thinking PLM, it's clear that, in developed countries, companies' future profits won't come from Manufacturing and Assembly of commodity products. Companies in a country where wage costs are 10% of those in the USA will be able to carry out those Manufacturing and Assembly activities at a much lower cost. To survive, companies in developed countries have to add value and create revenues elsewhere in the lifecycle. Opportunities include developing ideas for new environment-friendly products, providing customised products, providing services to support product use, refurbishing existing products, and taking financial and environmental responsibility for products produced in low-cost countries.

4.7.2 Thinking About the Company

Before PLM, when thinking about a company in simple terms, people broke it up into functional departments. Typical departments included sales, engineering, manufacturing, and after-sales. Jobs were defined with reference to those functions. They included sales person, design engineer, manufacturing worker, and after-sales service person. Information systems were implemented to help the functions in their work. There were CAD systems for engineering, MRP systems for manufacturing.

Thinking PLM, people view the company in terms of product lines. They identify the lifecycle for the product line. They look to build the best design chain and supply chain for that product line. They hire people to work in its product teams. They define lifecycle processes, and implement lifecycle PDM systems to manage the data across the lifecycle.

4.7.3 Thinking About a Function

Before PLM, people thought functionally about the company. A Marketing VP, an Engineering VP and a Manufacturing VP would report to the CEO. Managers of product lines would report in through a matrix.

Thinking PLM, people first think about the product lifecycle. A Chief Product Officer (CPO) has the responsibility for all the products across the lifecycle. The CPO reports to the CEO. So do the Chief Financial Officer (CFO) and the Chief Information Officer (CIO). Product Managers report to the CPO.

4.7.4 Thinking About an Activity

Before PLM, people would think about one activity in a company at a time. In the Engineering Department, without considering the needs of other people in the lifecycle, design engineers would buy new application software to design

products faster. In the Recycling Department, recycling specialists scratched their heads and wondered what they were going to do with the freshly-arrived truck-load of old products too difficult to disassemble for recycling purposes.

With PLM, people think about more than one activity at a time. They think about the product across its lifecycle. Engineers designing a product take account of how it will be manufactured. And how it will be disassembled and recycled. The recycling specialists keep up-to-date with environmental laws and keep development engineers informed. Together, they work out how to design products that can be disassembled quickly, and how to re-use parts in new products.

4.7.5 Thinking About the Product Development Activity

Before PLM, people would think about one activity in a company at a time. Product development, in particular, was often seen as a separate island, somehow disconnected from the other activities. Design engineers seemed to have problems communicating with people in other functions, so were left to work alone.

With PLM, people think about the entire product lifecycle, from cradle to grave. Product development is one of many activities in the lifecycle, and is closely integrated with the others. Design engineers talk to people in other functions to find out as much as possible about product needs and behaviour, and to learn about experience with similar products.

4.7.6 Thinking About Focus

Before PLM, the rule was "focus on the customer".

With PLM, the rule is "first focus on the product", then focus on the customer. Customers buy great products. Companies can have all the knowledge in the world about their customers, and what the customers have said, but they won't get a sale without a competitive product.

4.7.7 Thinking About Voices

Before PLM, the rule was listen to the "Voice of the Customer".

With PLM, the rule is "listen to the Voice of the Product as soon as possible". Get the product to report back about how it's working. And, of course, don't forget to listen to the "Voice of the Customer".

4.7.8 Thinking About Time

Before PLM, people thought towards the future: first came product development, then manufacturing, then support. Time goes forward. One thing comes after another.

With PLM, not only are there flows, such as time, going forwards. There are also flows going backwards. Information comes back from product operation to be used in product development. Feedback about the use of one generation of a product helps improve future generations. Products that have reached the end of their life are disassembled, and some parts are reused in the start-of-life of new products.

4.7.9 Thinking About Customers

Before PLM, people would carry out a Customer Survey to find out what customers thought of existing and future products.

With PLM, people think Customer Involvement. Using technologies such as mobile telephony, GPS, Radio Frequency Identification (RFID) technology and Web 2.0, they exchange information directly with a customer who is using the product. Getting feedback from a customer at the actual time of use provides more valuable information than a survey form.

4.7.10 Thinking About the Portfolio

Before PLM, people in Marketing and Sales would refer to the product portfolio. This was the portfolio of existing products. Meanwhile, people in Engineering would refer to the project portfolio. This was the portfolio of new products in the pipeline.

With PLM, everyone in the lifecycle refers to the Integrated Portfolio which contains both the existing products and those under development.

4.7.11 Thinking About the Product

Before PLM, people would think bottom-up, starting with parts and building up to the product. After parts were developed, it would be found that they didn't fit into assemblies. So they were redesigned. Assemblies were redesigned to fit together. Companies developed some parts in one CAD system, then found, because of differences in CAD data representations, that they didn't fit with parts developed in

other CAD systems. Engineers developed data transfer software to address the problem. Engineers wasted time down at the level of bits and bytes, instead of focusing on the product.

With PLM, people start by thinking about the Integrated Portfolio, then work down through product families, platforms, and modules, to products, and then to parts. PDM systems manage the information about a product across its lifecycle. Maybe a company will outsource design engineering, and won't need a CAD system. Maybe a company will outsource Manufacturing. Maybe Assembly will be limited to putting together a few dozen major modules. Engineers focus on the product, which creates value, and not on the bits and bytes.

4.7.12 Thinking About the Product Lifecycle Approach

Before PLM, the many product-related issues weren't considered together. For example, Product Recall, Product Development and Product Liability would be addressed separately and independently.

With PLM, all the product-related issues are united under PLM and are addressed together in a joined-up way. The approach is holistic. PLM is seen as the way to address all the product-related issues.

4.7.13 Thinking About the Management Role

Before PLM, product-related issues weren't considered to be a subject for management.

With PLM, top managers understand and can formulate the need for effective product lifecycle management. They define the key metrics. And how the activity will be managed.

4.7.14 Thinking Profit or Planet

Before PLM, companies often put profit before the planet. They fouled the air, the water and the land. They burned wood, coal and oil as if there was no tomorrow. Major corporations boasted of their success while much of mankind lived in poverty and squalor, and died young of preventable hunger and disease.

With PLM, companies think profit and planet. They take more account of non-financial issues, such as the environment, social issues, health, education and sustainable development.

4.7.15 Thinking About Processes, Data, Applications

Before PLM, companies thought about ourProcesses, ourData, ourApplications. In the extended enterprise environment, each inter-organisation interface (process, data, or application) was a source of chaos, adding costs and slowing down lifecycle activities.

With PLM, companies think of the standard processes, standard data and standard systems that they, and their numerous suppliers, customers, and partners in the extended enterprise environment, can use to save an enormous amount of time and money.