Chapter 2
Product Lifecycle Management

2.1 Product Lifecycle Management (PLM)

PLM is the business activity of managing, in the most effective way, a company's products all the way across their lifecycles; from the very first idea for a product all the way through until it is retired and disposed of.

PLM manages both individual products and the Product Portfolio, the collection of all of a company's products.
PLM manages products from the beginning of their life, including development, through growth and maturity, to the end of life.

The objective of PLM is to increase product revenues, reduce product-related costs, maximise the value of the product portfolio, and maximise the value of current and future products for both customers and shareholders.

2.2 Managing the Product Isn't Easy

There are five phases in a product's lifecycle (Fig. 1.4). In each of the five phases, the product is in a different state. During the imagination phase, the product is just an idea in people's heads. During the definition phase, the ideas are being converted into a detailed description. By the end of the realisation phase, the product exists in its final form (for example, as a car) in which it can be used by a customer. During the use/support phase, the product is with the customer who is using it. Eventually the product gets to a phase in which it's no longer useful. It's retired by the company, and disposed of by the customer.

The product must be managed in all these phases to make sure that everything works well, and that the product makes good money for the company. That means managing the product throughout its lifecycle, "from cradle to grave".

J. Stark, *Product Lifecycle Management (Volume 2)*,
Decision Engineering, DOI 10.1007/978-3-319-24436-5_2

Managing the product across its lifecycle isn't easy. During the development of a product, it doesn't physically exist. Not surprisingly, during that phase of life it's difficult to control. Once a product does exist, it should be used at a customer location, where again, it's difficult for a company to keep control of it.

Within a company, the responsibility for the product is often different at different phases of the lifecycle. At one time it may be with Marketing, at other times with Engineering or Service. Maintaining a common coherent approach among these organisations, which may have different objectives, working methods and applications, can be difficult and time-consuming.

It becomes even more challenging in the Extended Enterprise environment. The issues are then no longer just cross-functional but also cross-enterprise. And it becomes even more challenging when a company works in different Extended Enterprises for different products. At different times the responsibility for the product may then be with different Marketing, Engineering, Manufacturing, Product Management, Finance, Marketing, Sales and Service groups in different companies. They may be on several continents, in different time zones and speaking different languages.

2.3 Loss of Control

In such an environment, it's easy for companies that develop, produce and support products to lose control over a product. But, if a company loses control, the consequences can be serious. If it loses control during product development, the product may be late to market and exceed the targeted cost. The results of losing control during use of the product may be frustration and a lack of satisfaction for the customer, or much worse, injury and death. For the company, the results may be damage to the company's image and loss of customers concerned about product problems. They could also include loss of revenues to companies that bring products to market faster, and reduced profit due to costs of recalls and legal liabilities resulting from product use.

An example of a product that was late to market is the Airbus A380. Delivery of the first A380 was originally planned for the last quarter of 2005. It was eventually delivered in the second half of 2007, two years late. The cost of late delivery was estimated to be $6 billion. Another example is the Airbus A400M program, which was launched in 2003. The development cost was estimated initially at about €20 billion, with first delivery planned for 2009. By 2009, the potential development cost had risen to about €30 billion. The first delivery was made in 2013.

The problem with the A380 occurred well into the development project. However, problems with products can occur even earlier in their lives, for example during their specification. At the time of the commercial launch of the Airbus A350 in December 2004, it was expected to enter service in 2010. The initial specification was based on an extension to an existing aircraft. That implied rapid availability and a relatively low development cost. However, in view of limited interest from

potential customers, an aircraft with a new design, the A350 XWB (Extra Wide Body), was proposed in 2006. Entry into service was announced for 2013, three years later than previously expected. The first commercial flight took place in January 2015.

Problems can also occur during product manufacture. For example, in 2006, computer makers such as Apple Computer, Dell, Hitachi, Lenovo and Toshiba announced the replacement of Sony-made lithium-ion batteries that could overheat in certain circumstances and pose a safety risk.

In January 2013, after problems with lithium-ion batteries on JAL and ANA Boeing 787s, the Federal Aviation Administration (FAA) ordered all 787s grounded. The order was lifted in April 2013 after battery and containment systems had been redesigned.

Problems can also occur during product use. On 25 July 2000, the crew of an Air France Concorde noticed a loss of power and a fire under the left wing soon after take-off from Paris. The aircraft went out of control and crashed onto a hotel. Two years earlier, on 2 September 1998, not long after take-off from New York, the flight crew of Swissair Flight 111, an MD-11, noticed an abnormal odour in the cockpit. Their attention was drawn to an area behind and above them, but whatever it was apparently then disappeared. They decided it was smoke and decided to land, unaware of a fire above the ceiling in the front area of the aircraft. The fire spread, degrading aircraft systems and the cockpit environment. The aircraft crashed into the Atlantic Ocean near Halifax, Nova Scotia.

Other problems with planes include disappearance (MH 370 in 2014) and deliberate crash (Germanwings Flight 9525 in 2015).

Problems with products can involve big numbers. In October 2003, Nissan Motor Company said it would recall 2.55 million cars at an estimated cost of 15–16 billion yen ($138–148 million) due to an engine defect. In a few months in late 2009 and early 2010, Toyota announced recalls of more than eight million cars due to concerns over accelerator pedals and floor mats. The cost was estimated at $2 bn. In January 2010, Honda announced the recall of more than 600,000 cars to fix a switch defect that could lead, in some cases, to a fire. In June 2010, GM recalled over a million vehicles due to thermal incidents with heated washer fluid systems. GM listed 84 recalls affecting 30,433,365 vehicles on its "GM 2014 year-to-date North American recalls including exports" web page. In April 2010, an explosion on the Deepwater Horizon drilling rig led to the death of 11 people. The blowout preventer failed to activate correctly. For months, tens of thousands of barrels of oil spilled daily into the Gulf of Mexico, totalling perhaps a hundred million gallons.

Problems can also occur at product end-of-life. For example, the French Ministry of Defence had problems in 2005 and 2006 with Q790, previously known as the aircraft carrier Clemenceau. With hundreds of tons of asbestos on board, dismantling the hull for scrap was never going to be easy. A failed attempt to dismantle Q790 in Turkey was followed by a decision to dismantle it in India. Q790 left Toulon in France at the end of 2005 to be broken up at Alang in India. After being refused entry to India, it was towed 10,000 miles back to France.

Merck voluntarily withdrew VIOXX, an arthritis and acute pain medication, in September 2004 because a trial had shown an increased relative risk for cardiovascular events. There were millions of users worldwide. VIOXX had been launched in 1999 and marketed in more than 80 countries.

If products don't meet the rules and regulations laid down by government and international authorities, there can also be problems. In 2001, authorities in the Netherlands found that some peripherals for a game console contained cadmium levels above the Dutch limits. Sony Corp. temporarily halted shipment. The estimated impact on sales was about 100 million euros.

Counterfeiting can be another result of loss of control. Companies making products as different as software, clothing, DVDs and pharmaceuticals suffer from product counterfeiting and product pirating. A 2009 report from the Organisation for Economic Co-operation and Development indicated that international trade in counterfeit and pirated products could have been up to $250 billion in 2007.

Another type of product-related problem was highlighted in 2006 when it was announced that the FBI had thwarted an attempt to steal and sell Coca-Cola's trade secrets, apparently including information about a new product.

Problems are not limited to high profile products and companies. Each month the website of the U.S. Consumer Product Safety Commission lists about 30 recalls of products such as drinking glasses that can break during use, cameras that can overheat, stools that can become unstable, lawn sprinklers that can crack, candle packaging that can ignite, and sweatshirt hood drawstrings that pose a strangulation hazard to children. Other products recalled include hair dryers that can pose an electrocution hazard, window blind cords that can pose a strangulation hazard for small children, and bicycle fenders that can break, posing a fall hazard to the rider.

Similarly, each month the U.S. Food and Drug Administration lists about 20 recalls, market withdrawals and safety alerts of products such as frozen strawberries, eye drops, herring in sourcream, teriyaki salmon jerky, atracurium besylate injection doses, blood glucose test strips, wet wipes and pharmaceutical drugs.

And, each month, the Office of Defects Investigation of the National Highway Traffic Safety Administration lists about 20 Vehicle Recall Reports addressing parts such as automatic transmissions, fuel tanks, wiper motors, airbags, brake hose assemblies, front passenger seat occupant detection mats, hoses, connectors, nuts and bolts.

2.4 Sources of Problems

Companies don't want to have such problems with their products. They can cost a lot of money. If a problem does occur, a company will do everything it can to understand the source, and to prevent the problem happening again.

In pre-emptive mode, it's also useful to identify and understand potential problems with a view to preventing them occurring. This isn't as easy as it may seem. There's a lot of information available about how to do things right. Much less

Problem Area	*Issue(s)*
Products	incorrectly, or unclearly, defined products
Product data	data out of control; data in silos; different definitions of data
Processes	processes not defined; unclear processes; conflicting processes
Applications	Islands of Automation; missing applications, ineffective interfaces
Projects	project status vague; unclear project objectives; too many projects
Equipment	machines and software licences under-utilised or not used
People	specific skills missing; lack of training
Organisation	working methods not defined; different methods used on different sites

Fig. 2.1 Some reasons for things going wrong with products

about how they are done wrong. Companies usually don't like to talk about their problems with products. However, sometimes the information becomes public. The Press may take an interest. Accident reports may be published. Technical journals publish case studies and other articles. And of course, people working with many companies, such as consultants, get to see the inside story. From these sources, conclusions can be drawn as to why things go wrong (Fig. 2.1).

2.5 Opportunities of Globalisation

The above issues can occur when a company operates in one country. However, globalisation has led many companies to operate in many countries. This has made it even more difficult to keep control of products. It's led to new ways to lose control of products.

Globalisation can have many effects on a company, even a small one. One positive effect is that, because of globalisation, it 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 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 result of the increased competition is that companies have to be more innovative, develop better products, develop them faster and develop them at lower cost.

Globalisation also implies that companies have to be close to customers in many places, and to understand customer requirements and sell products in many environments. However, the situation in different countries is different. Companies have to understand and take account of these differences. For example, they have to get pricing right in many different environments. They also have to provide technical information, parts, products and service in many locations. They must meet regulations in many countries. They have to coordinate the launch of new and modified products for the global marketplace.

The opportunities for sales and profits resulting from globalisation are enormous. As a result of the changes, the potential market for most companies is no longer a

few hundred million customers for the product in a local regional market, but over 7 billion customers and users worldwide.

The opportunities are enormous, but so are the difficulties and potential risks. Many questions have to be answered. For which geographical markets should we offer our products? The whole world? One continent? Several continents? Just a few countries? If so, which ones? Should we introduce a new product everywhere in the world at the same time, or introduce it first in one market, then in the others? Do we understand these markets well enough? Should we have one product for customers throughout the world? Where will we develop our products? In a single location where we can bring our best people together and give them the best tools in the world?

Which business processes should we use? Which IS applications? Should we use the same processes and applications everywhere in the world? If not, what must be global, what can be local? Should we use a set of IS applications from just one vendor, and hope that will eliminate integration problems between applications in different application areas? Or should we use best-in-class applications in each area, even if they are from different vendors and do not integrate well? Where should we store the product data that defines our products? And how can we keep it safe from envious prying eyes?

Such questions, and their answers, are part of PLM, the management of a product across its lifecycle.

2.6 The Environment Before PLM

In the environment before the emergence of PLM, the paradigm for managing a product across the lifecycle was piecemeal. There was an Alphabet Soup of many activities and approaches, most known by a Three Letter Acronym (TLA) (Fig. 2.2). Each of these helped manage a product at a different moment in its life. Each had technical objectives, not business objectives. With this piecemeal approach, organisations didn't manage products in a joined-up way across the product lifecycle. For example, product development and product support were often carried out in different parts of the organisation even though they addressed the same products. Because they were addressed in different parts of the organisation, the activities were carried out by different groups of people with different managers. Each group created its own processes, defined its own data and

JIT	- Just In Time		CAD	- Computer Aided Design		ESI	- Early Supplier Involvement
VA	- Value Analysis		ABC	- Activity Based Costing		CAE	- Computer Aided Engineering
GT	- Group Technology		DFE	- Design For Environment		QFD	- Quality Function Deployment
LCD	- Life Cycle Design		NPD	- New Product Development		CAM	- Computer Aided Manufacturing
VE	- Value Engineering		DFM	- Design For Manufacturing		ERP	- Enterprise Resource Planning
DFA	- Design For Assembly		NPI	- New Product Introduction		BPR	- Business Process Reengineering
LCA	- Life Cycle Analysis		TQM	- Total Quality Management		EMI	- Early Manufacturing Involvement

Fig. 2.2 Alphabet soup for managing a product

document structures, and selected its own IT applications. Each group solved its own problems as best it could, adding an application here, a document there. Each group optimised its own activities, even though this might mean reducing overall effectiveness.

All these activities resulted, to some extent, in the company managing its products throughout the lifecycle. However, the way they managed them didn't result from a clear, deliberate, documented plan, but from the way the company organised other activities. The subject of how products were managed across the lifecycle hadn't been explicitly addressed by company management. It wasn't planned. It wasn't documented. In such a situation, often nobody in the company could describe in detail how the products were managed throughout the lifecycle. The resulting environment was one of all sorts of gaps, contradictory versions of the same data, information silos, islands of automation, overlapping networks, duplicate processes, redundant data functionality, ineffective fixes and product recalls. The end result was reduced revenues and higher costs.

2.7 PLM Paradigm

The PLM Paradigm emerged, as a way to avoid such problems, in the early 21st Century. It was driven by changes in the business environment that required better management of products. Improvements in technology made its emergence possible. The PLM Paradigm sees PLM as one major business activity with business objectives. It differs in many ways from the previous paradigm.

For example, PLM has a holistic approach (Fig. 1.3) to the management of a product. It addresses resources such as products, data, applications, processes, people, work methods and equipment. This holistic approach distinguishes it from the environment before PLM, in which activities, such as Product Data Management (PDM) and Business Process Management (BPM), focused on one particular resource.

PLM is "joined-up". With PLM, the organisation manages the product in a coherent joined-up way across the lifecycle. PLM brings together what was previously separate, for example, product development and product support (Fig. 1.2). PLM joins up many previously separate and independent processes, disciplines, functions and applications, each of which, though addressing the same product, had its own vocabulary, rules, culture and language.

Use of the term PLM implies that the activity of managing products across the lifecycle is clearly-defined, well-documented, proactive, and carried out according to a particular design. It's carried out to meet specific objectives of increasing product revenues, reducing product-related costs, maximising the value of the product portfolio, and maximising the value of current and future products for both customers and shareholders.

2.8 PLM Grid

On the horizontal axis of the PLM Grid (Fig. 1.5) are the five phases of the product lifecycle. On the vertical axis are the resources that have to be addressed when managing a product.

A simple 5 × 10 grid might seem too small to be of any use to a company's PLM efforts. However, it's often said that a picture is worth a thousand words. A lot of information can be communicated in a simple picture. For example, a small plaque on the side of the Pioneer 10 spacecraft, launched in 1972, is intended to give information (such as source and sender) to whatever form of life might find it. Communication was lost with Pioneer 10 in 2003. By 2015, it should have been nearly 11 billion miles from Earth, heading towards the Taurus constellation. The small plaque includes five graphics, and measures about 6 in. by 9 in. Small as it is, it provides enough information to introduce a different form of life, so it's not surprising that a 5 × 10 grid can be very useful for communicating about PLM.

The Grid gives companies that develop and support products a way of visualising PLM.

The PLM Grid helps show why the environment of the product can be so difficult to manage. The scope of the environment is broad. Many subjects are addressed, ranging from methods for identifying ideas for new products, through organisational structure, to end-of-life recycling equipment. The scope is wide, but that reflects the reality of managing products.

The PLM Grid is useful in many PLM activities. The most basic of these is communication of the scope of PLM. The Grid can also be used in many other circumstances such as for: increasing PLM awareness; discussing with PLM project team members; communicating with business executives; documenting the current situation of PLM; defining the PLM Vision, Strategy and Plan; and discussing with vendors of PLM products and services (Fig. 2.3).

2.9 Starting the PLM Initiative

When starting a PLM Initiative, it's important to make sure that management understands PLM. Make sure that PLM is brought to the attention of the most important participants, and make sure that they buy into the idea. The Initiative has

communicate about PLM	document the status of a PLM implementation
discuss the scope of PLM in a company	document the current situation of PLM
document the scope of PLM in a company	document and communicate a company's PLM Vision
communicate the scope of PLM in a company	communicate a company's PLM plan
communicate the contents of PLM in a company	provide a basis for cross-functional discussion
define PLM in a company	communicate a checklist for PLM activities
explain PLM in a company	set the basis for talking to vendors of PLM products
provide a basis for comparison	document the status of a PLM implementation

Fig. 2.3 Applications of the PLM grid

unclear justification for introducing PLM	doubts about migration paths for existing systems
incorrect definition of needs	uncertainty about PLM Return On Investment (ROI)
lack of skills and knowledge	departments disagreeing about working methods
lack of implementation support tools	fear of starting an ERP-style enterprise-wide mega-project
lack of understanding of available solutions	underestimate of management and training requirements
underestimate of the required investment	difficulty of objectively identifying the benefits of PLM systems
concern about high costs	lack of clarity about the scope of PLM
lack of interest after initial setbacks	difficulty of defining responsibilities of system vendors
lack of clarity about what to integrate	difficulty of defining responsibilities of system integrators

Fig. 2.4 Reasons for lack of success in PLM projects

to come at the right time for the company, and it has to show that PLM is relevant and applicable in the company's particular situation. Participants need to see how the Initiative meets their needs and how it will be of benefit for them as individuals. They need to believe that it's feasible to implement PLM, and to see how to achieve it step-by-step. The Initiative needs to be packaged in such a way that participants can understand it easily, and can spread the message to those around them.

Be aware that, as with any other improvement initiative that can offer a high return on investment, a project to implement PLM can be risky. Although PLM provides a solution to the challenges of the changing environment for product development, manufacturing and support, its implementation can be complex and have many repercussions. For example, what may appear at first as the simple purchase of a technical document management system, or the development of an online product catalogue—both of which could be components of a PLM solution—soon raises questions about the way it will be used and maintained. Other questions will be asked about how it fits with other systems, what training is needed, how to manage the data, which working methods to use, and how to communicate with suppliers and customers. And as more and more components of PLM are addressed, the complexity increases.

As a result, there is a high failure rate for PLM initiatives. Many overrun, many don't meet business objectives. A survey among PLM users and potential users showed many reasons for lack of success (Fig. 2.4).

http://www.springer.com/978-3-319-24434-1

Product Lifecycle Management (Volume 2)
The Devil is in the Details
Stark, J.
2016, XXXII, 634 p., Hardcover
ISBN: 978-3-319-24434-1