The development of an integrated model for the implementation of a Product Data Management system at Delta Motor Corporation.

By

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Promoter: Prof. Koot Pieterse

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TO WHOM IT MAY CONCERN

RE: CONFIDENTIALITY CLAUSE

This work is of strategic importance.

It would be appreciated if the contents of this research paper remain confidential and not be circulated for a period of five years.

Sincerely,

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T.J. Stroud

ABSTRACT

Information technology in mature organisations is viewed as an enabler of teams working together in the product development process. Technology is no longer pursued as an end in itself, but for its contribution to cost control, product quality, and most importantly, time to profit.

The focus of this research is the analysis of methodologies used to implement the Teamcenter Engineering Product Data Management (PDM) system at Delta Motor Corporation, which manages all of Delta's CAD data.

The main problem of this research is as follows:

How can Delta Motor Corporation successfully implement the "Teamcentre Engineering" Product Data Management System?

The main problem will be broken down into three distinct parts, namely the developing of a best practice process, analysing Delta's implementation and making recommendations for improvement.

The literature survey provides the basis for developing a best-practice process, which serves as a benchmark against which to evaluate the methodology used by Delta. Interviews were conducted with selected personnel who were involved in the implementation, and Tesch's model for content analysis used to analyse the responses.

The implementation process of Teamcenter Engineering at Delta was conducted in three phases and only the first was completed at the time of writing this research paper. For this reason, analysis revolves around the first phase of implementation, which was limited to the drawing office, while recommendations are made for the implementation of phase two and three, which roll-out this system to the rest of Delta and it's supplier base.

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INTRODUCTION

Integrated Product Development (IPD) requires the integration of people, business processes and information technology across the product development value cycle. The technology must support the business process by enabling the users to get their tasks done and link them to other tasks in the process. This means interfacing applications and sharing data across organisational functions as well as with suppliers and customers (Conaway 1995).

A typical product development value cycle includes capturing the customer requirements, product design, analysis and testing /simulation, development of manufacturing processes and supporting information and prototyping the product. For products which are assembled from parts and subassemblies, these functions must be performed for all complex components as well as the final product. Purchasing of parts for the prototype may also be considered to be part of the product development cycle.

In the past, end manufacturers tended to design most complex subassemblies as well as the final assembled product. The trend today is to outsource the subassembly design or to do it with cross-functional teams, which include representatives from the supplier. This increases pressure for the technology to support exchange of design information and sharing of data between manufacturers and suppliers.

Looking closer at the product development cycle for complex products, we can see four dimensions of integration that must be supported by the technology in an enterprise level IPD system.

First is the integration of the business process (concept to design to manufacturing) for a particular project dealing with a component or subassembly. Second is the integration of the workflow and applications that support the tasks in the project. Thirdly, the multiple projects must be co-ordinated in a program that deals with the entire assembled product. Finally the organisations that participate in the implementation of the IPD system, including suppliers, vendors and the manufacturer should be integrated.

Information technology in mature organisations is viewed as an enabler of teams working together in the product development process. Technology is no longer pursued as an end in itself, but for its contribution to cost control, product quality, and most importantly, time to profit. While a case can be made that traditional technology components themselves (e.g. CAD, CAT and CAPP systems) make some contribution to these business goals, the big payoff in team performance comes from integrating the technology in a networked computing environment backed up by shared product and process data (Conaway 1995).

1.1 MAIN PROBLEM

During the last decade, the manufacturing industry has made significant investments in using information technologies to automate various processes in the product life cycle. This demand has nurtured the rapid growth of the computer-aided design, manufacturing, engineering, and computer-integrated manufacturing (CAD/CAM/CAE/CIM) market since the late 1970s. However, this trend has also resulted in a phenomenon known as "Islands of Automation", which continues to plague the manufacturing industry.

Starting in the mid 1980s, a new class of applications called Engineering Data Management (EDM) emerged. EDM applications, also known as Product Data Management systems, have a common purpose of providing configuration management between existing engineering datasets and the key objective of these systems is to bridge the gaps between islands of automation (Tsao 1993).

Simply acquiring the tools is not enough to ensure success, as many highly sophisticated systems end up poorly utilised and grossly ineffective due to poor planning and implementation of the system.

The focus of this research is the analysis of methodologies used to implement a product Data Management system, in order to develop a “best practice” process for implementation. This process was then be used to analyse the implementation of “Teamcenter Engineering” PDM at Delta Motor Corporation, by comparing the actual approach taken to best practice, and then making recommendations for improvement.

The main problem of this research can therefore be stated as follows.

How can Delta Motor Corporation successfully implement the “Teamcentre Engineering” Product Data Management System?

1.2 SUB-PROBLEMS

The main problem was be broken down into three distinct parts, namely the developing a best practice process, analysing Delta’s implementation and making recommendations for improvement. These sub-problems can therefore be articulated as follows.

1.2.1 Sub-Problem 1

What process does the research literature reveal to effectively implement a Product Data Management System?

1.2.2 Sub-Problem 2

What process was used by Delta Motor Corporation in implementing the Teamcentre Engineering Product Data Management System?

1.2.3 Sub-Problem 3

What recommendations can be made to improve the implementation process at Delta Motor Corporation?

1.3 DELIMITATION OF THE RESEARCH

Delimiting the research serves to make the research topic manageable from a research point of view, and the omission of certain aspects of the topic does not imply that no research is warranted.

1.3.1 Automotive Industry

The South African motor industry incorporates the manufacture, distribution, servicing and maintenance of motor vehicles and components and plays a vital role in South Africa's economy, contributing about 5,4% of the country's R801 billion Gross Domestic Product (NAAMSA 2003).

1.3.2 Delta Motor Corporation

Delta Motor Corporation is one of the key players in the South African motor industry, with two assembly plants in Port Elizabeth and its head office in Johannesburg. Delta maintains a significant market share in both the passenger and commercial vehicle segment by assembling the high volume models locally and importing lower volume models to diversify its range.

Delta's original plant is in Kempston Road Port Elizabeth, while the new plant is located in Struandale. The Kempston Road plant houses most of the support staff of the business including the Product Development Department.

1.3.3 Product Development

All design data managed by the Teamcentre Engineering PDM system originates from the Product Development Department, where the Design Office is located. This research will be taking place exclusively in the Product Development Department, due to the fact that Phase one of the implementation of this system only includes roll-out in this area.

1.3.4 Drawing Office

My investigations into the methodology used to implement this system included interviews with a senior CAD designer in the drawing office, a member of the information technology support staff and the departmental manager, who championed the implementation process. I also interviewed a member of the software vendor company, who installed the system, provided support and trained key personnel in the use and administration of the system.

1.4 DEFINITION OF KEY CONCEPTS

- Bill of Material

  A Bill of Material (BOM) is a list of components required to manufacture a certain product or sub-assembly. It also shows the relationship between higher and lower assembly components.

- Bandwidth

  Bandwidth is defined as the maximum data rate at which a network can transfer data. It is typically measured in megabits per second (Mbps). It can also be described as the range of frequencies that can be accommodated on a particular telecommunications network (Laudon and Laudon 2002:244).

- Benchmarking

  Benchmarking occurs when companies set strict standards for products, services or activities and measure organisational performance against these standards. Benchmarking could also include evaluating competitor's products to gauge relative performance strengths and weaknesses (Laudon and Laudon 2002:315).

- Computer-Aided Design (CAD)

  The complete design and specification of a component or system using computer hardware and sophisticated software, instead of drawing boards and paper.

- Computer-Aided Manufacture (CAM)
  The manufacturing of components or systems using CAD data that is digitally transmitted to the computer controlled manufacturing equipment. CAD/CAM is used for example in the manufacture of press tools for sheet metal parts.

- Database
  A database can be defined as a collection of data organised to service many applications at the same time by storing and managing data so that they appear to be in one location (Laudon and Laudon 2002:209).

- Electronic Manufacturing Measurement (EMM)
  3D CAD technology is interfaced with 3D measuring machines to evaluate a component's dimensional accuracy to design.

- Firewall
  Hardware and software is placed between an organisation's internal network and external network to prevent outsiders from invading private networks (Laudon and Laudon 2002:276).

- Information System
  An information system can be defined technically as a set of interrelated components that collect (or retrieve), process, store and distribute information to support decision making, co-ordination and control in an organisation.

- Integrated Product Development
  Integrated Product Development (IPD), also called Concurrent Engineering, requires the integration of people, business processes and information technology across the product development value cycle. The technology must support the business process by enabling the users to get their tasks done and link them to other tasks in the process.

- Original Equipment Manufacturer (OEM)
  Typically relating to motor vehicle manufacturers, it refers to a company

selling a complete vehicle as opposed to sub-components.

- Product Data Management
  A Product Data Management system includes strategies and solutions related to product development and pre-production processes, including approaches and technologies that streamline these processes and the ways in which conceptual and product data is communicated throughout the supply chain (DesMarteau 2002).

- Product Lifecycle Management (PLM)
  PLM is not so much a new technology, as it is a set of existing technologies linked together in a new way and from a new perspective, making product information available and relevant to anyone in the organisation who needs it. PLM is a set of technologies incorporating design, simulation and testing information, procurement and logistics, manufacturing data, and even customer relationship management/sales data (CRM), all within the confines of an overarching information architecture. It is built around the fundamental idea that performance of a product is the driver of the product lifecycle (Fernandez 2002).

- Teamcenter Engineering
  Teamcenter Engineering is a Product Data Management system developed by EDS, based initially on a product called “iMAN”, and it forms part of a suite of Teamcenter products such as Teamcenter Enterprise, Teamcenter Manufacturing, Teamcenter Requirements and Teamcenter Project.

- Unigraphics
  Unigraphics is a 3D Computer-Aided Design (CAD) software package developed by EDS, which along with its closest rival CATIA, leads the international CAD arena, used in such applications as vehicle and aircraft design.

1.5 KEY ASSUMPTIONS

It is assumed that generic guidelines exist that serve to differentiate between good and bad practices in the implementation of PDM systems, and furthermore, that these processes are applicable to the motor industry in South Africa, including Delta Motor Corporation.

1.6 THE SIGNIFICANCE OF THE RESEARCH

Studies indicate that up to 70 percent of an engineer's time is spent looking for information produced by others rather than on creative engineering work. Information Technologies (IT) under consideration within the automotive and aerospace manufacturing industries that address this issue include Product Data Management and Workflow Management. While four elements, namely people, information, applications, and processes, must be managed electronically, today's PDM and WM systems allow management of only some of these elements in isolation. The result is severe inefficiencies due to replication and inconsistencies. WM integrated with PDM is critical to the unified management of these elements. This integrated approach implemented with a commercial PDM and a generic, object-based WM product, recently has demonstrated productivity improvements at several leading manufacturing sites (Ramanathan 1996).

Delta Motor Corporation has embarked on managing its CAD and other data through a Product Data Management system, one of the motivating factors for this initiative being the need to keep abreast with General Motors' global trends. The researcher became involved in this implementation in February 2003, at which time he was appointed as project implementation champion. This appointment gave the researcher the opportunity to gain in-depth insight into both PDM systems and the internal processes at Delta, while also providing a platform for conducting this research.

1.7 AN OVERVIEW OF RELATED LITERATURE

Fries (1995) states that successful implementation of Product Data Management systems requires careful planning and analysis. Typically nine key steps need to be followed to ensure a successful implementation, and subsequent reaping of the performance and efficiency benefits.

- Identify your needs
  It is essential to be realistic about your needs and requirements as an organisation and be practical with how you will satisfy them.
- Gain support
  The right people must be involved in the process to gain a full understanding of how information flows throughout the company and where the biggest bottleneck areas exist.
- Analyse your requirements
  A few meetings should be taken up purely with this step, but care must be taken not to delay in the analysis process as one can become side-tracked on trivial issues.
- Justify the cost
  In justifying the cost of the project, the focus should be on business requirements first, not technology, to demonstrate the practical benefits to be gained.
- Select a vendor
  A list of vendors that offer potential solutions should be developed and evaluated. An evaluation methodology that fits your company's style and time frame should be selected, the vendors compared with this standard and the most suitable selected. References are essential for all vendors.
- Design the system
  In conjunction with the vendor, the system needs to be customised to best fit your organisation’s culture and processes.
- Plan the implementation
  When implementing a project of this magnitude, the focus should be on incremental projects that scale up gradually over time.

- Ensure Success
  The success of the project needs to be the highest priority and regular evaluations of progress versus the implementation plan must be held. Strong leadership is required to overcome organisational resistance to the changes brought about by the implementation, and the benefits need to be constantly highlighted to remind people of the importance of a successful implementation.
- Maintain the System
  Both system software and data need to be maintained at the latest level at all times to ensure system integrity and prevent users from losing confidence in the accuracy and usefulness of the system (Fries 1995).

Laudon and Laudon (2002:25) highlight five key management challenges in the area of information systems in the digital firm.

- The strategic business challenge:
  How can businesses use information technology to become competitive, effective and digitally enabled?
- The globalisation challenge:
  How can firms understand the business and system requirements of a global economic environment?
- The information architecture and infrastructure challenge:
  How can organisations develop an information architecture and information technology infrastructure that can support their goals when business conditions and technologies are changing so rapidly?
- The information systems investment challenge:
  How can organisations determine the business value of information systems?
- The responsibility and control challenge:
  How can organisations ensure that their information systems are used in an ethically and socially responsible manner?

John Kotter (Kreitner, Kinicki and Buelens 2002:548) believes that organisational change typically fails due to the fact that one of the following eight steps is not carried out.

- Establish a sense of urgency
- Create the guiding coalition
- Develop a vision and strategy
- Communicate the change vision
- Empower broad-based action
- Generate short-term wins
- Consolidate gains and produce more change
- Anchor new approaches in the culture

The value of Kotter’s model is that it provides specific recommendations regarding the behaviours required by managers to successfully lead change. Senior managers are therefore advised to focus on leading rather than managing change.

According to Gould (2002) Product Lifecycle Management is a strategic business approach that applies a consistent set of business solutions in support of the collaborative creation, management, dissemination and use of product definition information across the extended enterprise from concept to end of life integrating people, process, and information. PLM forms the product information backbone for a company and its extended enterprise.

Olsen and Reitz (2002) maintain that through product data management software, companies have a means of learning from their mistakes while capturing the original intention of the project. “Wouldn't it be nice to know what engineers were thinking as they attempted a particular design? What happened while testing a particular design? What steps were taken to resolve a problem? Why were specific changes made to a part?” (Olsen and Reitz 2002). Companies also need to associate marketing data with technical data because marketing and engineering often operate on different levels. Having marketing and technical data creates a vivid picture of what the market looked like and how the needs of the market were interpreted at that time.

Hill (2001) states that studies within the automotive industry revealed that the payback from collaborative technology is substantial, but it usually starts to reflect on the bottom line about five years after implementation. “Companies that have stuck with collaborative technology programs for that long usually see 5 percent to 10 percent improvement in their profit margins, with those improvements coming from a combination of new revenues and lower operating costs" (Hill 2001).

Philpotts (1996) believes that PDM systems and methods provide a structure in which all types of information used to define, manufacture and support products are stored, managed and controlled. Typically, PDM will be used to work with electronic documents, digital files and database records. In short, any information needed throughout a product's life can be managed by a Product Data Management system, making correct data accessible to all people and systems that have a need to use them.

1.8 RESEARCH DESIGN

In this section, the broad methodology that was followed in the study is described.

1.8.1 Literature survey

Key steps and processes required for successful implementation of a product Data Management system were identified.

1.8.2 Empirical study

The empirical study took the form of a survey of draftsmen, supervisors and managers within the Product Development department at Delta Motor Corporation, and the software vendor was also interviewed. A questionnaire was constructed to act as a guide when conducting semi-structured interviews with the above participants.

The purpose of this survey was to determine the actual methodology used by Delta in implementing the Teamcenter Engineering PDM system.

1.8.3 Development of an integrated process

The results of the survey were then compared to the literature survey and recommendations made.

1.9 LIST OF INTENDED CHAPTERS

Chapter 1	Introduction
Chapter 2	Literature Study
Chapter 3	Situation Analysis
Chapter 4	Research Design
Chapter 5	Results and Discussion
Chapter 6	Conclusion and Recommendations

This concludes the introduction and overview of this research paper, and a comprehensive literature study follows in the chapter two.

CHAPTER 2
LITERATURE STUDY

Implementing a new information system in a company is a long, costly and difficult process and the benefits to be gained often take a long time to be realised.

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2.1 THE COMPETITIVE BUSINESS ENVIRONMENT AND THE EMERGING DIGITAL FIRM

There have been four powerful changes on a global scale that, according to Laudon and Laudon (2002:4), have profoundly altered the business environment. These four changes are the emergence and strengthening of the global economy, the transformation of industrial economies and societies into knowledge and information based service economies, the transformation of the business enterprise and the emergence of the digital firm.

2.1.1 Emergence of the Global Economy

Today, information systems provide the communication and analytical power that firms need for conducting trade and managing business on a global scale (Laudon and Laudon 2002:5). Global trade requires effective competition in world markets with global delivery systems and international work groups interacting with each other across vast distances.

2.1.2 Transformation of Industrial Economies

The major industrial powers of the world are being transformed from industrial economies into knowledge and information based service economies, with manufacturing being moved to low-wage countries. The key ingredients to creating wealth are therefore having knowledge and controlling information (Laudon and Laudon 2002:5).

2.1.3 Transformation of the Business Enterprise

The traditional firm is a hierarchical, centralised, structured arrangement of specialists that typically relied on a fixed set of operating procedures to deliver a mass-produced product or service. The new style of business firm is a flattened, decentralised, flexible arrangement of generalists who rely on nearly instant information to deliver mass-customised products and services uniquely suited to specific markets or customers (Laudon and Laudon 2002:6).

2.1.4 The emergence of the digital firm

The digital firm can be defined along several dimensions, according to Laudon and Laudon (2002:6). A digital firm is one where nearly all of the organisation's significant business relationships with customers, suppliers and employees are digitally enabled. Core business processes are accomplished through digital networks spanning the entire organisation or linking multiple organisations. Business processes refer to the unique manner in which work is organised, co-ordinated and focussed to produce a valuable product or service. Key corporate assets, such as intellectual property, core competencies, financial and human assets are managed through digital means. Digital firms sense and respond to their environments far more rapidly than traditional firms, giving them more flexibility to survive turbulent times.

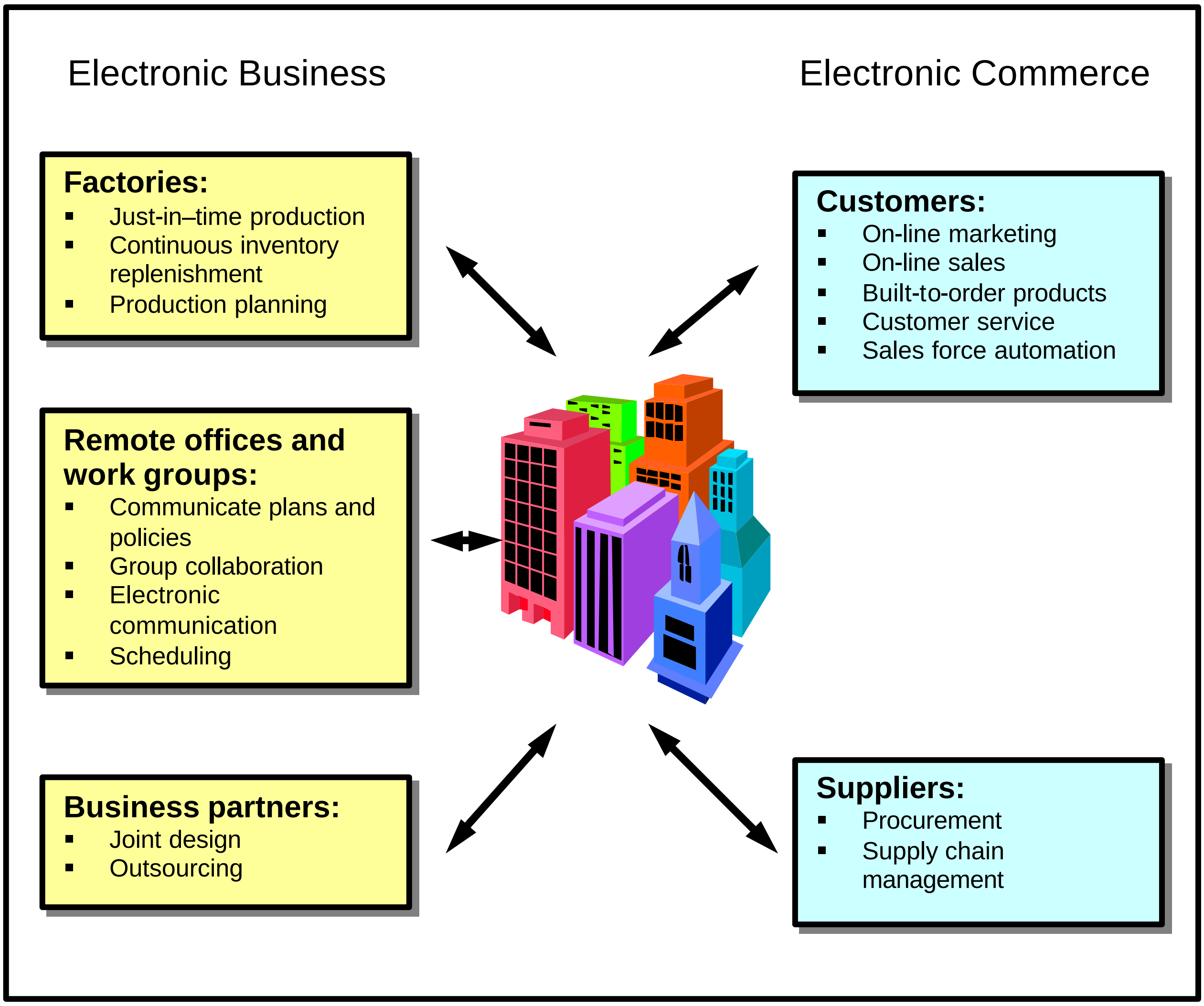

Figure 1: The Emerging Digital Firm (Laudon and Laudon 2002:26)

2.2 INFORMATION SYSTEMS AND BUSINESS STRATEGY

Certain types of information systems have become especially critical to firms' long-term prosperity and survival. Such systems, which are powerful tools for staying ahead of the competition, are called strategic information systems. Strategic information systems change the goals, operations, products, services or environmental relationships of organisations to help them gain an edge over competitors (Laudon and Laudon 2002:85).

Traditional models of strategy are being modified to accommodate the impact of digital firms and new information flows. The emphasis is on exploring, identifying, occupying new market niches before competitors act, understanding the customer value chain better and learning faster and more deeply than competitors.

There is generally no single all-encompassing strategic system, but instead there are a number of systems operating at different levels of strategy, such as business, firm and industry level strategies.

2.3 THE CHALLENGE OF ENTERPRISE SYSTEMS

Although the benefits of enterprise systems can be substantial in the long run, these systems have proven difficult to build. Laudon and Laudon (2002:58) highlight four significant challenges facing firms implementing enterprise-wide systems.

2.3.1 Daunting Implementation

Firms implementing enterprise systems have to come up with organisation wide definitions of data, retrain thousands of workers, and redesign their fundamental business processes, while still carrying out business as usual. It might take a large firm three to five years to fully implement all of the organisational and technological changes required by an enterprise system.

2.3.2 High Up-front Costs and Future Benefits

The costs of enterprise systems are large, up front and often politically charged. The benefits are often difficult to quantify precisely at the beginning of a project, as employees are likely to show productivity improvements only after gaining experience with the new system.

2.3.3 Inflexibility

Due to the integrated nature of enterprise systems, it is often difficult to change parts of the system without affecting other parts as well. Enterprise systems tend to be complex and difficult to master, with a shortage of people having the expertise to maintain them.

2.3.4 Realising Strategic Value

Companies may also fail to achieve strategic benefits from enterprise systems if integrating business processes using generic models provided by standard software packages prevents the firm from using unique business processes that had been sources of advantage over the competition (Laudon and Laudon 2002:58).

2.4 MANAGING CHANGE

Increased competition and startling breakthroughs in information technology are forcing firms to change the way they do business. Companies no longer have a choice – they must change to survive. Change is, however not always easy to achieve as people frequently resist organisational change even when it is for a good reason (Kreitner, Kinicki and Buelens 2002:540).

2.4.1 Forces of Change

The origin of change in an organisation can be either internal or external and these forces of change need to be carefully monitored and evaluated to ensure that the organisation recognises when it needs to change. The external and internal forces for change are illustrated in Figure 2 below.

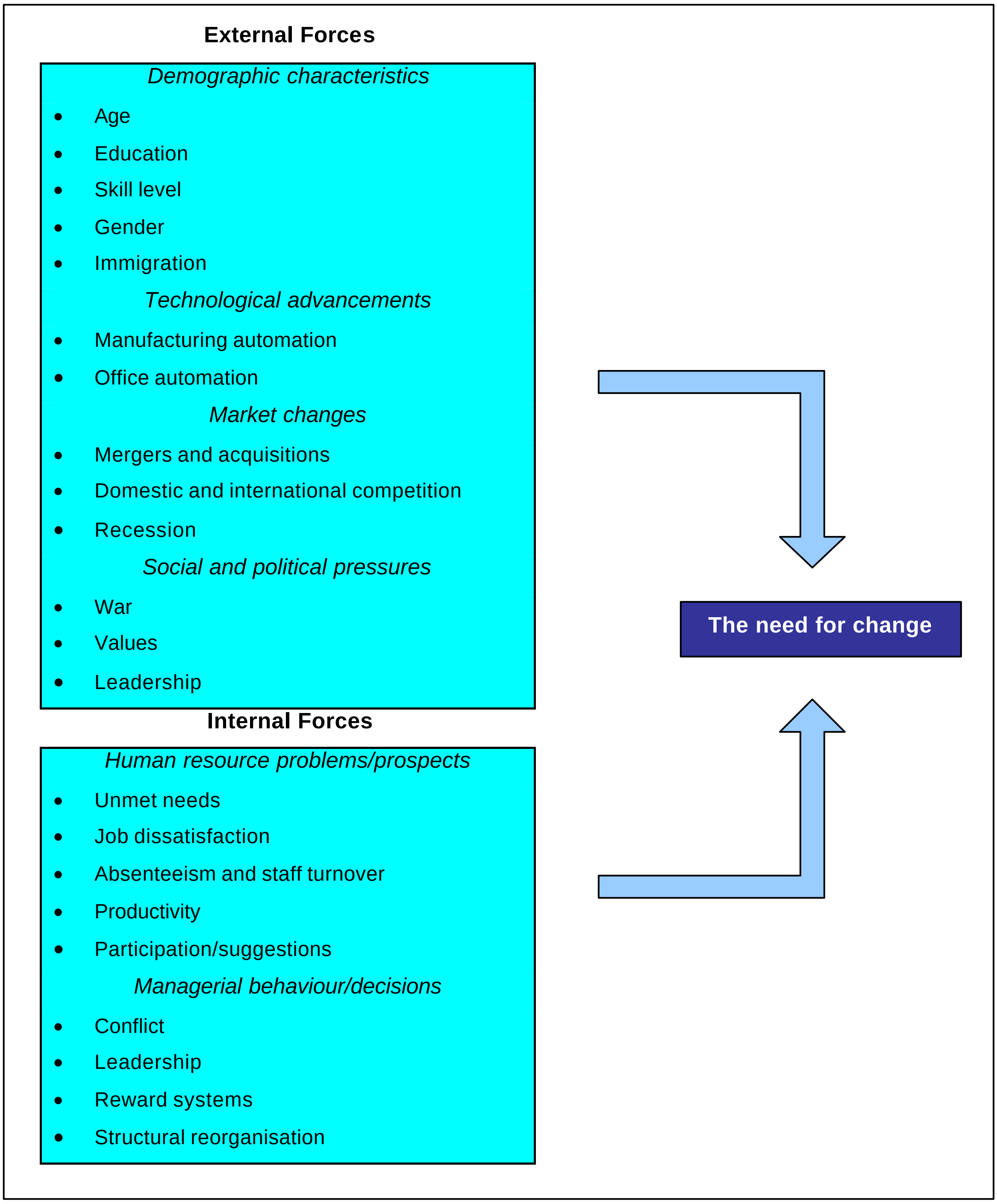

Figure 2: The External and Internal Forces for Change

(Kreitner, Kinicki and Buelens 2002:541)

External forces for change have global effects and may cause an organisation to question the essence of what business it is in and the process by which products and services are produced.

From a demographic perspective, the modern workforce has become increasingly diverse, requiring firms to manage this diversity effectively in order to achieve maximum commitment from employees.

Technological advancements have boosted productivity in both manufacturing and service orientated firms, improving their ability to compete effectively. Automated processes such as computerised numerical control (CNC) and computer-aided design (CAD) have changed the design to manufacture process into a seamless digital process. Office automation technologies used to store, analyse and retrieve information have radically improved the effectiveness of the service industry (Kreitner, Kinicki and Buelens 2002:542).

Market changes, brought about by the emergence of the global economy is also forcing companies to change the way they do business, while partnerships and alliances with suppliers and potential customers are increasingly being forged.

Social and political forces such as the rise in environmentalism and the formation of common market economies have forced firms to focus on issues not previously considered strategically important.

Internal forces for change may be subtle such as low job satisfaction, or they can manifest themselves as outward signs such as low productivity and conflict. Change can be brought about either through employees themselves or through management decision making.

2.4.2 Types of Change

A useful continuum can be drawn reflecting the types of change required in relation to the degree of complexity, cost and uncertainty, as well as the potential for resistance to change. This continuum introduces three types of change namely adaptive, innovative and radically innovative change (Kreitner, Kinicki and Buelens 2002:544).

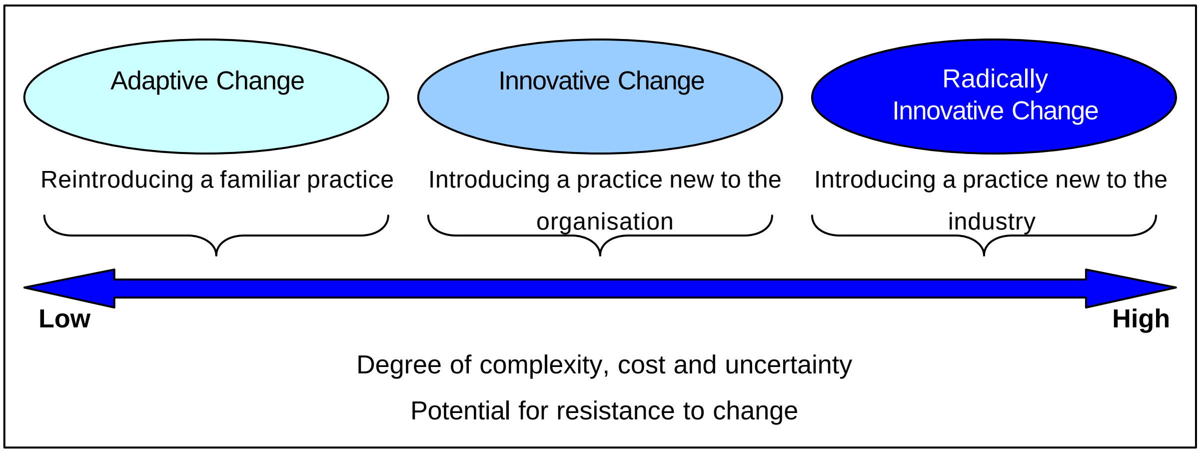

Figure 3: A Generic Typology of Organisational Change
(Kreitner, Kinicki and Buelens 2002:544)

Adaptive change is lowest in complexity, cost and uncertainty and involves repeating the implementation of a change in the same organisational unit. Innovative changes fall midway in the continuum and increased uncertainty makes fear of change a problem. Radically innovative changes fall on the high end of the continuum and are the most difficult to implement due to the threat they pose to both managerial confidence and employee job security.

2.4.3 Lewin's Change Model

Kurt Lewin developed a three stage model of planned change which explained how to initiate, manage and stabilise the change process (Kreitner, Kinicki and Buelens 2002:544). The three stages are "unfreezing", "changing" and "refreezing".

The basic assumptions that underlie this model are as follows.

- The change process involves learning something new, as well as discontinuing some current activities.
- Change will not occur unless there is motivation to change.
- People are at the heart of the change process, as any organisational change requires people to change.
- Resistance to change is found even when the goals of the change are highly desirable.

- Effective change requires reinforcing new types of behaviour, attitudes and organisational practices.

The focus of the “unfreezing“ stage is to create the motivation to change, by encouraging individuals to replace old behaviours and attitudes with those desirable by management. Benchmarking can be used to assist with the unfreezing of an organisation, by comparing its performance with those of its rivals in order to learn how they achieve their results.

Change is a learning process and all employees need to be kept informed regarding the new behavioural models and new ways of looking at things. Role models, mentors, experts, benchmarking results and training are all useful models to facilitate change.

Refreezing requires stabilising the change process by helping employees to integrate the new way of doing things into their normal work processes. Additional coaching and modelling can be used at this point to reinforce the change (Kreitner, Kinicki and Buelens 2002:545).

2.4.4 Kotter’s Eight Steps for Leading Organisational Change

John Kotter (Kreitner, Kinicki and Buelens 2002:548) believes that organisational change typically fails due to the fact that one of the following eight steps reflected in Figure 4 below is not carried out.

The value of Kotter’s model is that it provides specific recommendations regarding the behaviours required by managers to successfully lead change. Senior managers are therefore advised to focus on leading rather than managing change.

	STEP	DESCRIPTION
1	Establish a sense of urgency	Unfreeze the organisation by creating a compelling reason for why change is needed.
2	Create the guiding coalition	Create a cross-functional, cross-level group of people with enough power to lead the change.
3	Develop a vision and strategy	Create a vision and strategic plan to guide the vision.
4	Communicate the change vision	Create and implement a communication strategy that consistently communicates the new vision and strategic plan.
5	Empower broad-based action	Eliminate barriers to change and target elements of change to transform the organisation. Encourage risk-taking and creative problem solving.
6	Generate short-term wins	Plan for and create short-term “wins” or improvements. Recognise and reward people who contribute to the wins.
7	Consolidate gains and produce more change	The guiding coalition uses credibility from short-term wins to create more change. Additional people are brought into the change process as change cascades throughout the organisation. Attempts are made to reinvigorate the change process.
8	Anchor new approaches in the culture	Reinforce the changes by highlighting connections between new behaviours and processes and the organisational success. Develop methods to ensure leadership development and succession.

Figure 4: Sequential Steps to Leading Organisational Change
(Kreitner, Kinicki and Buelens 2002:548)

2.4.5 Overcoming Resistance to Change

Individual and group behaviour following an organisational change can take many forms ranging from acceptance to active resistance to change. Managers need to learn to recognise the manifestations of resistance to change in themselves and others if they wish to be successful in creating and supporting change. There are ten main reasons for resistance to change, which are discussed below.

- An individual's predisposition to change
- Surprise and the fear of the unknown
- Climate of mistrust
- Fear of failure
- Loss of status or job security
- Peer pressure
- Disruption of cultural traditions or group relationships
- Personality conflicts
- Lack of tact or poor timing
- Non-reinforcing reward systems

Although change can be difficult, Peter Senge believes that change success is possible. "When I look at efforts to create change in big companies in the past ten years, I have to say that there's enough evidence of success to say that change is possible and enough evidence of failure to say that it isn't likely" (Kreitner, Kinicki and Buelens 2002:540).

2.5 SYSTEMS AS PLANNED ORGANISATIONAL CHANGE

The introduction of a new information system involves much more than in installation of new hardware and software. It also includes changes in jobs, skills, management and organisation. One cannot install new technology without considering the people that must work with it. When we design a new information system, we are redesigning the organisation (Laudon and Laudon 2002:305).

2.5.1 Linking Information Systems to the Business Plan

It is crucial that organisations develop an information systems plan that supports their overall business plan and incorporates strategic systems into top level planning (Laudon and Laudon 2002:305). Once specific projects have been selected within the overall context of a strategic plan for the business and systems arena, an information systems plan can be developed. This plan serves as a roadmap indicating the direction of systems development, the rationale, the current situation, the management strategy, the implementation plan and the budget.

An example of the typical components of an information systems plan is indicated in Figure 5 below.

1. Purpose of the Plan

Overview of plan contents
Changes in firm's current situation
Firm's strategic plan
Current business organisation
Key business processes
Management strategy

2. Strategic Business Plan

Current situation
Current and future business organisation
Changing environments
Major goals of the business plan

3. Current Systems

Major systems supporting business functions
Current infrastructure capabilities:
  Hardware, software, database,
  telecommunications
Difficulties meeting business requirements
Anticipated future demands

4. New Developments

New system projects:
  Project descriptions, business rationale
New infrastructure capabilities required:
  Hardware, software, database,
  Telecommunications and internet

5. Management Strategy

Acquisition plans
Milestones and timing
Organisational realignment
Alliances and value partners
Internal reorganisation
Management controls
Personnel strategy

6. Implementation Plan

Anticipated difficulties in implementation
Progress reports

7. Budget Requirements

Requirements
Potential savings
Financing
Acquisition cycle

Figure 5: Information Systems Plan (Laudon and Laudon 2002:306)

2.5.2 Establishing Organisational Information Requirements

Two successful methods of establishing an organisation's long and short-term information requirements are through enterprise analysis and critical success factors (Laudon and Laudon 2002:305).

Enterprise analysis, or business systems planning, states that a firm's information requirements can only be understood by looking at the entire organisation in terms of organisational units, functions, processes and data elements (Laudon and Laudon 2002:306). Enterprise analysis can help to identify key attributes of the organisation's data.

Strategic analysis, or critical success factors argues that a firm's information requirements are determined by a small number of critical success factors. If these goals can be obtained, the organisation's success is assured. An important premise of the strategic analysis approach is that there are a small number of objectives that managers can easily identify and on which information systems can focus (Laudon and Laudon 2002:306).

2.5.3 Systems Development and Organisational Change

Information technology can promote various degrees of organisational change, ranging from incremental to far-reaching.

The four main categories of structural organisational change that are enabled by information technology are automation, rationalisation, reengineering and paradigm shifts (Laudon and Laudon 2002:309). Each results in different levels of reward and risk.

At the lower end of the risk/reward continuum is automation, which simply involves assisting employees to perform their tasks more efficiently and effectively. Rationalisation of procedures involves a deeper form of change, and usually follows on from automation, due to the fact that automation frequently exposes bottlenecks in existing systems.

Business process reengineering involves analysing, simplifying and redesigning business processes using information technology. This typically involves reorganising workflows, combining steps to reduce waste and eliminate repetitive, paper intensive tasks. A paradigm shift however, is a more radical form of change, which involves rethinking the nature of the business and the organisation itself. Paradigm shifts and reengineering often fail because extensive organisational change is so difficult to orchestrate, but due to the high rewards, these forms of change are worth pursuing (Laudon and Laudon 2002:310).

2.5.4 System Building Approaches

Systems differ in terms of their size and technological complexity, and can be designed around various system methodologies. The section that follows describes these different methodologies, namely the traditional systems lifecycle, prototyping, application software packages, end-user development and outsourcing (Laudon and Laudon 2002:320).

The *systems lifecycle approach* is the oldest method for building information systems, which clearly separates end users from information systems specialists, and typically involves the following six stages.

- Project definition
- Systems study
- Design
- Programming
- Installation
- Post-implementation

Although this approach is still useful for building large complex systems that require rigorous and formal requirements analysis and tight controls, it is often costly, time consuming and inflexible. This approach is not suitable for small desktop systems, which tend to be less structured and more individualised.

Prototyping consists of building an experimental system rapidly and inexpensively for end users to evaluate. By interacting with the prototype, users can get a better idea of their information requirements, while an iterative process is followed to improve the system through multiple versions until final release.

Typical steps in the prototyping process are listed below.

- Identify the user's basic requirements
- Develop an initial prototype
- Use the prototype
- Revise and enhance the prototype

Although prototyping can be very effective in developing a system that suits customer needs, care needs to be taken not to gloss over important developmental steps, resulting in an unpolished system that is hastily implemented (Laudon and Laudon 2002:323).

Application software packages are common to all business organisations and cover such processes as payroll, accounts receivable and inventory control. Such standardised packages can save the organisation the time and effort of redeveloping custom applications for many standard processes. Many of these software packages also include the option of customisation, to allow users to modify the system to a certain extent to meet organisational needs. Once a software package is selected, the organisation will be required to adapt to the way it operates, as not all aspects of the system design will match the traditional business processes of the firm (Laudon and Laudon 2002:324).

End-user development occurs when information systems are developed by end users with little or no formal assistance from technical experts. Modern software tools allow greater access to data and provide powerful reporting tools that can easily be customised by advanced users. End-user development tends to allow far quicker response times in developing systems that suit the user's needs. The risk lies in the lack of formal development methodology, testing and documentation. Control of data may also be lost, as it becomes increasingly difficult to determine where data are located as well as to ensure consistency of data and systems throughout the organisation (Laudon and Laudon 2002:325).

Outsourcing occurs when a firm decides not to use its own internal resources to build or operate information systems, but appoints an external company that specialises in this kind of work to do the job. This methodology has become popular as firms perceive it as more cost effective than maintaining their own personnel or computer departments to perform this function. Not all organisations benefit from outsourcing however, as firms may lose control of their strategic information systems if the process is not managed correctly (Laudon and Laudon 2002:326).

2.6 SYSTEM IMPLEMENTATION STRATEGIES

PDM and workflow automation offers enormous benefits for many organisations but achieving the maximum benefit from this technology requires spending a substantial amount of time analysing your situation, defining your requirements, establishing goals and planning for successful automation (Fries 1995).

2.6.1 Successful Implementation of Product Data Management Systems

Fries (1995) states that successful implementation of Product Data Management systems requires careful planning and analysis. Typically nine key steps need to be followed to ensure a successful implementation, and subsequent reaping of the performance and efficiency benefits promised by the system.

a) *Identify Your Needs*
It is essential for the organisation to be realistic about its needs and requirements and practical in how it intends satisfying them. A system implementation that is not focused on satisfying specific needs is doomed to fall short of achieving its organisational objectives.

b) *Gain Support*
The right people need to be involved in the process so that a full understanding of how information flows throughout the company can be gained, and the major bottleneck areas can be identified (Fries 1995).

c) *Analyse Your Requirements*
A few meetings should be taken up purely with requirement analysis, but care must be taken not to stay too long in this stage as one can easily become side-tracked on trivial issues.

d) *Justify the Cost*

In justifying the cost of the project, the focus should be on business requirements first, not technology, to demonstrate the practical benefits to be gained. Practical and relevant performance measures should be implemented, such as standard times to perform typical activities, so that improvements can be quantified, both in justifying the cost versus benefit relationship, as well as actual gains resulting after the implementation.

e) *Select a Vendor*

A list of vendors that offer potential solutions should be developed and evaluated. An evaluation methodology that fits the company's style and time frame should be selected, the vendors compared with this standard and the most suitable selected. References and examples of previous system implementations are essential for evaluating all vendors.

f) *Design the System*

In conjunction with the vendor, the system needs to be customised to best fit your organisation’s culture and processes. Reference should be made to the requirements analysis stage, during which business processes were identified and documented (Fries 1995).

g) *Plan the Implementation*

When implementing a project of this magnitude, the focus should be on incremental projects that scale up gradually over time. A comprehensive plan, including detailed activities, responsibilities and timing should be drawn up and maintained through regular meetings with all relevant players to ensure activities remain on track.

h) *Ensure Success*

The success of the project needs to be the highest priority and regular evaluations of progress versus the implementation plan must be held. Strong leadership is required to overcome organisational resistance to the changes brought about by the implementation, and the benefits need to be constantly highlighted to remind people of the importance of a successful implementation.

i) *Maintain the System*

Both system software and data need to be maintained to the latest level at all times to ensure system integrity and prevent users from losing confidence in the accuracy and usefulness of the system (Fries 1995).

2.6.2 Ten Steps to Ensuring a Successful PDM Project

Rudy (1995) proposes ten key points intended to provide practical advice when evaluating and implementing PDM systems:

a) *Be realistic about your needs and requirements and practical in how you will satisfy them*.

Since PDM systems offer good solutions to diverse corporate problems, there is a tendency to want to attack them all at once. Most organisations however, can only effectively handle one project at a time and therefore the PDM project should always be approached from a practical focused business perspective.

b) *Don't over-analyse your Product Data Management problem before starting the project*.

Due to the fact that PDM will be a relatively new concept within the organisation, it is likely that management would not be able to envision everything they want to accomplish at the outset. One of the biggest mistakes companies make is to focus on reengineering their organisations before even beginning the project. While reengineering is relevant and critical to PDM success, it is important to focus the first PDM projects on efforts which can quickly return knowledge about PDM implementation issues. This knowledge will then be the foundation for judging how much reengineering the PDM system actually requires (Rudy 1995).

c) *Assemble a team of people who understand how information flows throughout the company and can identify the bottlenecks*.

It is unusual for any one person in the company to be familiar with all areas of product information. A group of four to five product-knowledgeable employees from areas such as design engineering, document control, manufacturing engineering, purchasing and management should be assembled. The team should understand the company's strategic initiatives and be able to target improvement in five or six key areas. Focus on addressing problems one at a time so that objectives can be accomplished relatively quickly. Achieving short-term objectives is vital for maintaining corporate support for the project, gaining knowledge of what PDM technology can accomplish for larger projects and instilling confidence in the implementation team.

d) *Determine requirements in a few meetings.*
If it takes more than four or five meetings to determine system requirements, the team members are probably inappropriate for the task at hand. Due to the dynamic nature of the process, if too much time is taken studying a problem, it will probably change before the study is complete (Rudy 1995).

e) *Focus on business requirements first, not technology*.
The cross-functional team should include someone knowledgeable of the company's vision and strategy. Use this individual to keep the group focused on the business reasons for implementing a PDM system. Avoid looking purely at technology issues as the real concern should always be whether significant business value is being added to the company. The PDM project's value should always be greater than the effort, time and money it takes to accomplish its goals.

f) *Develop a list of vendors that offer potential solutions*.
Once the issues and problems have been identified, a vendor should be located that matches up with the company's requirements

g) *Choose an evaluation methodology that fits your company's style and time frame*.
No single methodology is right for every company but the objective is ultimately to end up with a product that best meets the company's defined requirements. Some companies will achieve this through

performing in-house benchmarks, while others don't have the staffing and use different technical evaluation methodologies. Some employ external consulting organisations to direct projects, while others never use them. Regardless of the approach, an evaluation plan is required that will truly verify what each product can do.

h) *Evaluate how a vendor and its products match up with your business and technology requirements*.

The following questions need to be asked to ensure that the vendor and its products are suitable.

- Does the product match your corporate directives or strategy?
- How much consulting are you willing to contract in order to get your product up and running?
- Does the proposed solution integrate with your design environments?

The chosen supplier should be able to solve the organisation's business problems, since many PDM marketing promises do not match up to reality (Rudy 1995).

i) *Ask for references - then follow up*.

Companies that have already implemented similar PDM systems should be visited to confirm how a vendor and its products and services stack up. If a supplier cannot supply references, then you should have serious concerns about its ability to deliver successful solutions.

j) *When implementing, focus on incremental projects that scale up*.

As noted earlier, one of the biggest mistakes companies make is to try to bite off more than they can chew. Starting small and scaling up allows the company to develop its skills, reduces the need to make a major investment in products up front and allows trouble spots to be addressed early on in the process (Rudy 1995).

2.7 CHAPTER SUMMARY

There is therefore a significant amount of literature suggesting that information technology is a strategic challenge for businesses. Selecting and implementing the right solution for the applicable company is a crucial decision that cannot be made without careful and in-depth investigation into both organisational and system requirements. Managing the organisational change process is however, often the greatest challenge of the implementation. Organisations embarking on technological change should therefore plan for all aspects of the implementation in a systematic manner and assign appropriate resources to manage the process.

CHAPTER 3
SITUATION ANALYSIS

The electronic revolution has profoundly changed the way we conduct business, the motor industry is no exception. Product Data Management and Enterprise systems organise and connect all aspects of product design, specification and manufacture, provide opportunities for international design collaboration, and significantly cut time to market for new products through inter alia virtual prototyping. Electronics systems now control all aspects of the vehicle including the engine and transmission, security, entertainment, climate control and various other gadgetry designed to make the driving experience more comfortable and unique. Marketing and sales techniques now include the internet as a legitimate channel directly to the customer, while communication between Original Equipment Manufacturers (OEMs) and their suppliers have moved into the electronic arena with such tools as Collaborative Exchange (CX), which manage supply releases.

To be a competitive player in the modern industry requires that companies not only embrace the new technologies, but actively seek new ways to maximise the benefits of these technologies in terms of improved co-ordination and reduced cost. Failure to do so will leave them unprofitable, irrelevant and unable to compete in the global marketplace.

Vehicle buyers have evolved into what is now being referred to as “the new customer”, who is typically a lot stronger and mobile than ever before.

Key characteristics of the new customer are:

- Knowledge (access to vast amounts of information)
- Despotic (they know what they don't want)
- Lack of loyalty (easily switches brands based on personal benefits)

(Rhys 2003)

All this translates into an extremely difficult and competitive market requiring constant attention to customer's needs and preferences to retain market share.

3.1 AN OVERVIEW OF THE SOUTH AFRICAN MOTOR INDUSTRY

The South African motor industry incorporates the manufacture, distribution, servicing and maintenance of motor vehicles and components and plays a vital role in South Africa's economy, contributing about 5,4% of the country's R801 billion Gross Domestic Product (NAAMSA 2003).

The industry has developed considerably during the past 50 years and has evolved from initially being an importing industry into an increasingly self-sufficient facility of vehicle manufacture, distribution, servicing and maintenance (NAAMSA 2003).

3.2 STRATEGIES FOR SUCCESS IN THE MOTOR INDUSTRY

In the light of global domination of the vehicle industry by a few multinationals, how can smaller companies, and more specifically South African companies survive? The key lies in finding the right niche and developing a tailor made strategy which exploits their own unique competencies and strengths. The key issues for developing this winning strategy can be summarised as follows:

- Focus on core competencies
- Build strategic alliances (internationally)
- Exploit the unique strengths of the firm
- Develop a strategic approach to outsourcing
- Develop new management disciplines (multiple relationships, learning from alliances)
- Adapt organisation structure for maximum efficiency (partnerships, high power business teams, skill acquisition)
- Exploit a range of technologies
- Extract value from core competencies
- Maximise benefits from strategic alliances

(Rhys 2003)

The key is to find out what you are good at and to build these competencies, with the help of strategic alliances, into an internationally competitive force. Technology and company flexibility are key elements for success.

3.3 GENERAL MOTORS GLOBAL INFORMATION TECHNOLOGY STRATEGY

General Motors Europe’s Chief Information Officer (CIO), José Carlos Eiras, explained how the automotive giant had gone from no IT strategy to a fully-fledged digital business in six years. At the 2002 Economist CIO and IT directors' summit he stated that GM was transforming into a true "real-time corporation" in which strategic leadership, high-speed business processes and digitisation differentiated GM from the competition" (Hall 2002).

Before GM embarked on this major IT restructuring process in 1996, it had no CIO, no IT governance and a poorly managed supplier relationship. This led to an IT 'legacy of many', with significant network instability and multiple solutions for the same problem, including 40 different SAP projects, 7 000 legacy information systems, no common desktop environment or email system and 23 computer-aided design (CAD) or manufacture (CAM) systems. The confusion also meant technology adoption was slow and GM lagged behind its competitors (Hall 2002).

At the Economist conference, three words stood out from Eiras' presentation namely "slow", "inefficient" and "costly". The world's biggest automotive company was not acting globally or leveraging its size to any effect. Disparate business units and poor partner relations, combined with an intensely competitive industry operating at over capacity under increasing regulatory pressures, meant something had to be done fast to turn the company around (Hall 2002).

The company's first ever CIO, Ralph Szygenda, was appointed to spearhead the transformation and a ten-year outsourcing contract was signed with the newly independent EDS. Szygenda's vision was a world-class information systems and services (IS&S) organisation capable of propelling GM to world leadership (Hall 2002).

This was the largest ever hiring of talent for one company. The largest manufacturing corporation in the world built an IT department from scratch. The worldwide GM IS&S organisation was responsible for strategy, budgets and programme management. Most staff came from outside, with some GM people from other areas of the business included to maintain GM culture and bring knowledge of the EDS years. GM was preparing to tackle legacy and complexity head on with a brand new team, clear goals and strategic direction (Hall 2002).

Because the decision to divest EDS was made at the top, support for the IS&S plan was never lacking. A string of early successes bolstered support as costs came under control, the Y2K programme began to yield benefits and the company rode the dot-com wave and created value through the GM Business Web, developed by EDS to connect employees, customers and suppliers through one portal. Eiras insists that you cannot do what GM did initially, namely the outsourcing of the strategic part of IT, where users deal with their own IT budgets (Hall 2002).

Managing the tripartite arrangement between GM, EDS and the users was Eiras' biggest challenge. "It's not enough to introduce a new structure and expect all parties to react positively," he says, "particularly when the users had been used to a great degree of autonomy. You have to earn respect from vendors and users through strong leadership" (Hall 2002).

Its all part of transforming GM into a real-time corporation. "There are two aspects to it," explains Eiras. "One is the speed at which you can introduce change. The other one is real-time systems." Merging web applications with transaction applications and developing the infrastructure to support them is key, as GM focuses increasingly on Customer Relationship Management. In Brazil, 70 per cent of sales from the large entry-level segment already take place online, a figure GM would love to see emulated across the globe. "The other aspect of it is real-time in terms of responsiveness to changes in the business, in the marketplace and in technology."

GM has also introduced the concept of Repeatable Digital Validation (RDV), which is a process that integrates digital representations of products into GM's business processes to increase the rate of internal communication, learning and decision making (Global Engineering Integrator 2002:1). RDV means repeatedly validating the fit, form and function of the digital model (refer to Appendix 5).

Central to GM's remarkable transformation in the six years since the divestiture of EDS is IT's shift from inhibitor to enabler. IT costs are now one per cent or less of total sales for Vauxhall and Opel, effective metrics have been put in place, common global solutions introduced and a competitive sourcing environment is being developed. There have been productivity gains in all areas. Market share, profitability and quality have all also gone up while cycle times, delivery times, time to launch, costs and decision times have gone down (Hall 2002).

In both the US and Europe, the big contribution being made by IT is the speed with which car programmes can be developed. In 1995, this process took GM 48 months, the worst in the industry. Today, it takes just 18 months (Hall 2002).

3.4 AN OVERVIEW OF DELTA MOTOR CORPORATION

Delta Motor Corporation is the fourth largest automotive company in South Africa, with a market share of 12.6% and a franchise dealership network of 187 dealers located throughout Southern Africa (www.delta.co.za). Delta's strengths include many years of experience in the motor industry, a strong link with General Motors (49% owned), competitive products in terms of performance, styling and quality, and due to it's size and independence from source-plant control, the ability to adapt quickly to local market conditions (www.delta.co.za). Delta is facing difficult challenges in the months and years ahead as the costs of developing new products locally escalate due to the technologies and systems required. A new approach is required to remain competitive both locally and internationally, that focuses on leveraging technology to manage corporate data, while reducing the product development cycle time, thereby lowering development costs and providing improved time to market.

3.5 DELTA MOTOR CORPORATION'S PRODUCT DATA MANAGEMENT REQUIREMENTS

Delta Motor Corporation is in the unique situation of being able to source data World-wide, directly from General Motors Sites using the Teamcenter Engineering Product Data Management system. In addition, in-house processes exist which require virtual product development and concurrent engineering facilities. Product Data Management systems, which facilitate the above, are therefore an essential part of the product development process at Delta (de Kock 2001).

The following is a list of requirements that a Product Data Management system needs to meet within the Product Development environment.

- Access and download data from the General Motors iMAN System in Germany and Brazil.
- Keep General Motors' downloaded data up to date and under configuration control.
- Be able to perform remote searches on the iMAN databases at preferred General Motors sites.
- Manage the Unigraphics Assemblies in terms of revisions, configuration and change.
- Provide a concurrent engineering capability, which will allow various designers to work on the same component assembly simultaneously.
- Provide a design, manufacturing, cost and maintenance BOM View facility.
- Manage as-designed, as-built and as-maintained baselines.
- Manage product-related data in conjunction with the part models, i.e. drawings, specifications and test reports.
- Perform engineering changes with workflow inside the PDM system.
- Sign-off completed product designs within the PDM system by means of a workflow process.
- Provide a view capability of the latest data on the buyer's desktop.
- Manage all laboratory test reports together with the product.
- Download the Bill of Material (BOM) to SAP by means of an interface.
  (de Kock 2001)

3.6 CHAPTER SUMMARY

This chapter illustrates clearly the advancement made in the global information technology industry, and specifically as regards CAD and PDM systems within the automotive industry. Delta is therefore not in a position to ignore there trends and continue with historical systems, as this will result in technology and data formats that become increasingly incompatible with both General Motors' global standards and the rest of the automotive industry.

Delta should therefore be embracing the new systems and technologies in order to remain competitive while reaping the benefits that these systems provide.

The chapter that follows provides insight into the research design and methodologies used to gather and analyse data for this study.

CHAPTER 4
RESEARCH DESIGN

This chapter explains the research methodology employed in conducting the research and links the research aims to the chosen design. The topics discussed include the research method, sampling, data-gathering instrument, research procedure and data analysis.

4.1 RESEARCH AIMS

The objective of this research was to establish the most effective process for implementing the Teamcenter Engineering PDM system at Delta Motor Corporation. The primary aims in this regard were firstly to develop a implementation process which explains the ideal structure, methods and strategies required to achieve a successful deployment of the system. The second aim was to analyse the process followed by Delta Motor Corporation from the identification of the need for this system, up to the present, to gain a full understanding of what has transpired. The third aim of this study was to compare the ideal process with the route followed by Delta Motor Corporation, highlighting the key differences between the two strategies from both a positive and negative viewpoint.

4.2 RESEARCH METHOD

In terms of the first aim, namely developing an ideal implementation process, a combination of Fries' (1995) strategy for successful implementation of Product Data Management systems and Rudy's (1995) ten steps to ensuring a successful PDM project were used for this study.

To analyse Delta Motor Corporation's implementation strategy for the Teamcenter Engineering PDM, a qualitative research method was selected and semi-structured interviews conducted on employees directly involved in the implementation process.

Leedy (1997:157) describes a number of qualitative research designs, of which the case study approach has been selected for this study. Case studies are a type of qualitative research in which the researcher explores a single entity or phenomenon, bounded by time and activity, and collects detailed information by using a variety of data collection techniques during a sustained period of time.

A case study is conducted to shed light on a phenomenon, be it a process, event, person or object of interest to the researcher. After defining a specific focus for the study, the researcher typically spends an extended period of time on-site with research participants in order to collect data from a wide variety of sources and to experience the phenomenon from the participant's perspective (Leedy 1997:157).

The main advantage of using a qualitative research method for this study is that it facilitates gaining access to the real-life perspectives and experiences of the participants, thereby providing the opportunity for feedback that could not be possible if a quantitative method were used (Denscombe 1998, Kvale 1983). The main disadvantage associated with a qualitative research method is that the information produced is largely a subjective creation of the interaction between the researcher and the participants (Denscombe 1998). Therefore, although the method is useful in describing the topic under research, the information gathered cannot reliably be generalised to deployments of systems in other companies.

Cavaye (1996:227) describes case study research as an accepted research strategy within the information systems environment. Case study methods can be used and applied in many ways and as such case research is open to a lot of variation.

The research approach applied in this study is both exploratory and descriptive, in that the research focused on a specific management process, in order to provide a detailed description of this process. The descriptive aspect of the research incorporated perspectives drawn from both the participants of the study and those drawn by the researcher from relevant literature.

4.3 SAMPLING

The target population for this study was individuals with direct involvement in the implementation process of Teamcenter Engineering within Delta Motor Corporation. Due to the relatively small number of people involved in this process, and the consequently small sample size of the study, a non-probability sampling strategy was selected, which according to Straits and Straits (1993) is the most suitable under these circumstances.

The major disadvantages associated with using a non-probability sampling strategy are the biases that may occur in the selection of a sample and the fact that generalisations from sample to population are then based on the researcher's judgement (Singleton, Straits and Straits 1993).

A brief introduction to the participants follows below.

4.3.1 Participant A

Participant A is the manager of the Engineering Services section of the Product Development and Planning department of Delta Motor Corporation, and as such he has the responsibility of managing various engineering support functions, including the design office. He has 25 years of experience in the research and development environment of Delta Motor Corporation, as well as serving three years at Isuzu Motors in Japan, as Engineering Liaison for Delta Motor Corporation.

- *Current position title/description:*
  Manager Engineering Services
  Responsible for the design office, laboratories, engineering parts list and technical data, project timing and engineering information systems.
- *Brief work experience (relating to CAD/PDM):*
  With the introduction of source plant CAD, a PDM system had to be introduced to manage this data at Delta. I have been involved with the introduction of GM iMAN from its inception.

- *Qualifications*:
  National Diploma (T4) in Mechanical Engineering
  Advance Diploma in Business Administration
- *Role in iMAN implementation at Delta*:
  Initiator of iMAN introduction at Delta and main driver to convert to iMAN use throughout the company to manage and control CAD data for internal and external (Supplier) access.

4.3.2 Participant B

Participant B is a director at ESTEQ Design (Pty) Limited, the software vendor responsible for Teamcenter and Unigraphics distribution in South Africa. His role in the Teamcenter Engineering implementation was to manage the project from the vendor perspective as well as to provide business and technical support to Delta.

- *Current position title/description*:
  Director - ESTEQ Design (Pty) LTD
  Responsible for Solid Edge Reseller Channel management for Southern Africa
  Project Manager for PDM implementations
  Account Manager for EDS software for the following companies:
  Delta, PBMR, IST
- *Brief work experience (relating to CAD/PDM):*
  Consulting: Logistic System Definition for Denel Aviation, Alvis (Ermetek), Debswana 1994 - 1997
  ESTEQ Project Manager for the PDM implementation at Cobra Watertech 1998 (Teamcenter Engineering)
  ESTEQ Project Manager for PDM implementation at Hamilton Airship Company 1999 (Teamcenter Engineering)
  ESTEQ Project Manager for the PDM implementation at PBMR 1999 (Teamcenter Engineering)
  ESTEQ Project Manager for the PDM implementation at IST 2000 (Teamcenter Engineering)

- *Qualifications:*
  B.Eng Mechanical (Pretoria University) 1983
  B.Eng Honors (System Engineering) (Pretoria University) 1986
  MBL (Unisa) 1993
- *Role in iMAN implementation at Delta:*
  Developed the initial PDM implementation plan on behalf of Delta Motor Corporation
  ESTEQ Project Manager for Phase 1 PDM implementation at Delta Motor Corp - 2002 (Teamcenter Engineering)

4.3.3 Participant C

Participant C has worked in the product design environment for the past 15 years and has gained extensive experience in all aspects of CAD design using Unigraphics, Catia, Micro CADAM and AutoCAD design software. He was appointed as a CAD Supervisor to take the responsibility of managing the transition of the design process to the managed Teamcenter Engineering PDM environment.

- *Current position title/description:*
  CAD Supervisor
  CAD Supervisor within the Delta engineering design office
- *Brief work experience (relating to CAD/PDM):*
  15 Years experience in Delta design office, extensive CAD experience and training using Unigraphics and exposure and training in Teamcenter Engineering PDM software.
- *Qualifications*:
  National Technical Certificate level 4 (NTC4) - Mechanical
- *Role in iMAN implementation at Delta*:
  Responsible for Unigraphics CAD aspects of the implementation including importing of legacy data, training and support of CAD designers during the transition to Teamcenter Engineering.

4.3.4 Participant D

Participant D is the System Administrator for the Procurement and Engineering departments at Delta, which include Engineering, Purchasing, Supplier Quality and Development and Material Cost and Sourcing. His responsibilities include the maintenance of 219 personal computers (in conjunction with IT department) as well as network administration. His responsibilities also include implementing and administering the Teamcenter Engineering PDM system.

- *Current position title/description:*
  System Administrator
  Administer and maintain hardware & software systems (including GM applications) of departmental users, in co-ordination with the IT department.
- *Brief work experience (relating to CAD/PDM):*
  Support users and administer all PC hardware & software issues and updates within Procurement and Engineering.
  Maintain Microsoft and other software product knowledge and training.
  Co-ordination and administration of all GM Engineering applications, including GPDS, GLOSSAR , APM, E2, GPDSVIEW, EDM, & EDS net user identification and passwords. Administer network drive access, downloading of all engineering drawing files and Installation and maintenance of the following engineering systems, (Electronic Part Catalogue, Technical Information System, and Information Handling Services).
  Administer and update all Procurement and Engineering log sheets, master lists, drawing requests, etc.
  Visview, Unigraphics, Teamcenter Engineering, Faro Measure and GM Toolkit Server\Client setup, installation and basic training.
- *Qualifications*:
  National Technical Certificate level 4 (NTC4) – Mechanical
  National Technical Certificate level 6 (NTC6) - Electrical
  A+\N+ Computer Support Comptia.
- *Role in iMAN implementation at Delta*:
  Purchasing of the hardware and software of the DMCIMAN server.
  iMAN Server\client setup and installation locally and with GM Brazil and GM Europe.

iMAN web network tunnel setup to Source plants.
iMAN remote setup and installation with GM Brazil and GM Europe.
User setup and user profile administration.

4.4 DATA GATHERING INSTRUMENT

One-on-one, face-to-face, semi-structured qualitative interviews were used to gather data in this study. Qualitative research interviews were considered advantageous as data gathering instruments in this study for the following reasons: Firstly, interviews provide data that is descriptively rich, which enhances the process of developing insight into hidden information (Denscombe 1998). Secondly, interviews are considered as being one of the most flexible data gathering instruments, in that the research schedule can be adapted to include any additional themes that may be highlighted by participants (Denscombe 1998). Thirdly, owing to the fact that the interview encounter is usually a prearranged event, a relatively high response rate for the study is ensured (Schurink 1998:300). Finally, semi-structured interviews are particularly useful when conducting exploratory research, according to Schurink (1998:300), in that they allow for "relatively systematic collection of data and at the same time ensure that important data are not forgotten". Making use of interview guidelines also allows for the monitoring of data collection during the interview process and this has positive implications for the validity of the study (Denscombe 1998).

Disadvantages associated with the use of qualitative research interviews include: the difficulty and time consuming nature of data analysis, and the possible effects of the interview situation, as well as the interviewer, on the responses of the participants and the ultimate interpretation of these responses (Denscombe 1998).

Although an interview guideline was used by the interviewer to focus on specific themes and questions considered relevant to the objective and aims of the study, participants were also given the opportunity to speak broadly (Schurink 1998).

The interview guideline (see Appendix 1) consisted of twenty questions, relating to each of the nine key elements of the ideal process. At the end of the interview, participants were also asked to comment generally on any relevant issues that were not covered by the questions.

4.5 PROCEDURE

Interviews were conducted at Delta Motor Corporation, using the available conference venues. An interview schedule comprising a list of open-ended questions was used to guide the interviews and to facilitate uniformity between the interviews. The interviews were recorded on audio tapes and then transcribed, so that a hard copy could be used during the analysis process. The data was coded by the researcher and was analysed, as outlined in the following section.

4.6 DATA ANALYSIS

In order to analyse the data in a way that met the aims of this research, Tesch's model of content analysis was used. Tesch provides specific steps which must be completed in analysing qualitative data. These steps are described by De Vos (1998) and it is useful to briefly outline these steps to clarify the procedure by which the data gathered during the interviews was analysed.

According to Tesch's model of content analysis, when analysing data, the researcher must first acquire insight into the data as a whole by reading through the transcripts of the data collection process a number of times (De Vos 1998). By doing this, the researcher will start to gain a better sense of how the data fits together. In addition, at this stage of the data analysis, the researcher must continually draw from his or her own experiences in order to make meaningful accounts or draw significant conclusions from the data. However, the researcher must also remain consciously aware of the impact of his or her own views and perceptions through the process. In order to do this, Tesch suggests that the researcher keep a record of any personal perceptions or judgements with regards to the text (De Vos 1998).

After gaining a holistic picture of the data, the researcher must examine each of the interview transcripts in turn in an attempt to understand what the interview is about. According to this model, this closer examination of the interview transcripts gives the researcher a better grasp of the underlying meaning in the information (De Vos 1998).

Once all the interview transcripts have been examined in this manner, Tesch suggests that the researcher make a list of all the topics and similar themes which have emerged during these readings. These themes should be grouped together and arranged into columns. The researcher is then able to divide the themes into major themes, unique themes and “leftovers” (De Vos 1998).

According to Tesch’s model, once this list of themes has been compiled, the next step is to give each of these themes a code by which it can be recognised. The researcher then returns to the transcribed data and writes these codes next to appropriate sections of the text in the interview transcripts. This serves to organise the text or transcripts into themes, but also serves to identify any new themes, which the researcher may have missed during previous readings (De Vos 1998).

The researcher, according to this model of content analysis, gives each theme a heading or title, which describes the content or nature of the theme. Data related to each of these categories is then grouped together and a preliminary analysis performed. By doing this, the researcher is able to identify themes which belong together and to group these into categories. Each of the categories of themes is abbreviated and can then be alphabetised. This serves to highlight possible interrelationships between various themes, which may lead to some of the themes being combined into one theme, and a subsequent shortening of the list of themes. If necessary, the researcher may choose to re-code certain data at this point (De Vos 1998).

The chapter that follows uses the above methodologies to gain insight and draw conclusions regarding the data gathered for this study.

CHAPTER 5
RESULTS AND DISCUSSION

The data gathering process was designed to probe the elements of the ideal model as listed below, and each of the questions were related to one of the nine aspects of the model. Refer to Appendix 2 for a summary of the participant's responses to the interview questions.

A number of themes emerged during the analysis process, which highlighted significant strengths and weaknesses of the implementation methodology employed. Each of these themes relates to one or more of the nine aspects of the model, as indicated below, and to facilitate analysis, related themes were grouped into main and sub themes.

- Identify Your Needs
  Effective management of CAD data
  Uniformity with GM and source plants
- Gain Support
  Convincing senior level management
  User-driven versus strategic company requirement
- Analyse Your Requirements
  System requirements not adequately determined up front
  The moving goal-posts
- Justify the Cost
  The bottom line approach
  Tangible versus intangible benefits
  Conditional approval
- Select a Vendor
  Software dictated by GM
  Software vendor dictated by local licensing agreements
- Design the System
  Standard system implementation - no customisation
  GM Toolkit

- Plan the Implementation
  Phase 1: Drawing Office
  Phase 2: Engineering Department
  Phase 3: Rollout to downstream departments and suppliers
- Ensure Success
  Software licensing and limited access
  Hardware limitations
  Volume of legacy CAD data
  Carrying over release levels
  Resistance to change
- Maintain the System
  Hardware maintenance
  Software maintenance
  User training

5.1 IDENTIFY YOUR NEEDS

Two themes emerged as the main drivers of change resulting in the implementation of Teamcenter Engineering. These needs arose out of a sense of desperation due to a misalignment between Delta Motor Corporation's systems and processes and its source plants, namely Adam Opel (Germany), General Motors Brazil, and Isuzu Motors (Japan). This misalignment lead to Delta's inability to effectively manage and control the new form of data supplied by its source plants on new product programs.

5.1.1 Effective management of CAD data

Having all CAD data under control and in a secure, accessible environment was the main priority for the engineering department at Delta. Clearly defined release levels are also critical for effective management of engineering changes.

a) *Growing volume of CAD data supplied by source plants*
Delta's source plants had advanced technologically to the point where all design data was available electronically directly from

their design offices. As new product programs were undertaken, the volume of CAD information grew to the point where it became difficult to locate and control the data within Delta's network, as no formal management system existed. One participant said: "*The big problem we had was we had a mass of data, which was difficult to manage*".

b) *Disparity between CAD and hard-copy release levels*

With two versions of the same drawing existing within the design office, namely the hard-copy on the old system, and the digital version on the network, discrepancies began to emerge between these two versions. Suppliers requested the CAD data to facilitate tooling design, while the hard-copy continued to be released via the traditional quotation process, and due to the lack of control of the CAD version, these two designs were not always the same, leading to confusion at the supplier. One participant said: *"You will find that someone will draw out a file, make a copy and that copy can multiply and you will find in every area on the network where there are drawings involved you may find that drawing duplicated all over".*

c) *Accessibility of CAD data to internal and external users*

As digital information in all forms began to be made available to users on their personal computers, the requirement for access to digital CAD information became apparent, due to the ease of access and quick search time. External users also began to express a need for CAD data in such applications as Electronic Manufacturing Measurement, which uses the three-dimensional CAD model for component measurement and dimensional validation. A system was therefore required which allowed external users controlled access to specific data. One participant commented: "*The other vision of ours is to expand iMAN beyond company boundaries where we provide access to information to our suppliers so that we can improve the process of information* *flow to our suppliers".*

d) *Control of drawing release level to internal and external users*
As mentioned above, two systems with identical information cannot be run side-by-side, as one data source always needs to take priority over the other. Managing the CAD data was obviously the main priority due to its benefits over the old paper-based system, and clearly defining release levels was a critical issue as it forms the basis of all product development work. One participant commented on this point by saying: "*The basic requirement of iMAN was that it had to manage the CAD data in such a way that we would at any point in time understand the latest information available, because many changes occur and we need to ensure that we have the latest information available".*

e) *Backup and maintenance of strategic design data*
Due to the sensitive and critical nature of the data for business success, a secure system was required that could manage and securely backup the data in case of disaster. Substantial amounts of money are paid to source plants for design data of this nature through global licensing agreements. Data loss would therefore not only threaten the development of the new product, but also cost a substantial sum of money to replace. Regarding data backup one participant said: "*We were looking for a stable background because Oracle was the database software and it has a stable back up function and the system is not maintenance hungry".*

5.1.2 Uniformity with GM and source plants

Delta realised that its data control system needed to conform to global GM processes. Compatibility with GM standards promised a smoother, more efficient data flow from source plants to Delta, and less time and effort wasted in converting data to suit local requirements.

a) *Unavailability of hard-copy and aperture card drawings from source plants*

Old sources of technical information, such as paper drawings and aperture cards (microfiche) started to dry up, creating a reliance on the digital information, thereby eliminating the option of staying with current paper-based control systems. One participant said: "…*all the information we see from source plants throughout the world is in Unigraphics computer format*".

b) *More efficient systems required for accessing source plant data*

Delta looked to General Motors plants world-wide for tried and tested systems to manage its product data. One participant said: "*We went back to GM to see how they managed their CAD data, in order not to reinvent the wheel*". Conformity with General Motors systems posed further benefits such as automatic data synchronisation instead of manual download of files. GM's global reach meant software discounts were available to Delta on systems used by GM. Delta's future product programs promise a reliance on more advanced data management systems requiring greater integration with overseas operations.

c) *Delta ownership by General Motors*

Many months of discussion have taken place at the highest levels regarding General Motors' ownership of Delta and the possibility of increasing the level of ownership from 49 percent to 100 percent. With this scenario in the background, system development decisions took into account that eventually, Delta may end up fully integrated into the GM global organisation. Conformity with GM systems and processes was therefore in Delta's own interests in the long term. One participant commented: *"…but not being an original OE design source we follow closely how General Motors operate"*.

5.2 GAIN SUPPORT

Gaining support for a large-scale system implementation is crucial, not only from a project approval process, but also to maintain momentum when organisational issues make the change difficult. As the need was initially realised in the engineering environment, this need had to be communicated from the ground upwards to senior management. This process proved to be a significant challenge.

5.2.1 Convincing senior level management

Senior levels of management, due to their position, typically do not have hands-on knowledge of information systems and both an education and justification process has to be undertaken. As one participant commented: "*It is very difficult to sell someone a software package without seeing tangible returns on investment and to gain support has been, and still is very difficult within the company… So it is very difficult, especially at executive level to get them to understand the benefits of having an iMAN system".*

a) *Establishing the need*

The need for a PDM system was illustrated by showing the volume of data received from source plants, and the lack of adequate control over the data. Intangible benefits, such as productivity improvements were also explained. One participant said: "*The basic requirement of iMAN was that it had to manage the CAD data*…".

b) *Demonstrating the suitability of the chosen system*

General Motors was used as the benchmark and as such Teamcenter Engineering was demonstrated to be the most suitable package for the application. One participant said: *"…we decided to do what GM is doing. They have done all the homework and we agreed that iMAN would be the best bet".*

c) *Justifying the cost*

The system cost was justified against the risk of uncontrolled data and the resultant errors in tooling which could cost hundreds of thousands of rands. One participant summarised this point as follows: "*The reasoning is that if we miss an engineering change and tooling is involved, this could easily cost from R300,000 to R1 million. We were running into new programs and the risk was very high. This was sufficient to convince the board to allow us to go ahead".*

5.2.2 User-driven versus strategic company requirement

A previously mentioned, the justification and motivation for this project came from the user departments and not as a strategic initiative by the company.

a) *Crisis intervention versus strategic planning*

Essentially, this project was undertaken as an intervention in a crisis situation, and not as a planned strategic initiative to keep Delta at the forefront of technology. One participant commented: "*the moment we got Unigraphics we found out that to manage all the documentation we needed a PDM system*".

b) *Lack of company support*

No company support existed prior to the justification process undertaken by the engineering department, and even after approval of the initial phase of implementation, Delta's IT department was unwilling to be involved in the implementation. The only support provided was in terms of connecting Teamcenter Engineering hardware and software into Delta's network and locating the server in Delta's secure server room. One respondent said: "…local installation of iMAN stuff I do myself".

c) *Shortage of IT specialists in implementation team*

The implementation team consisted mainly of engineering personnel with CAD experience, and one IT specialist who was also responsible for all product development and planning department IT issues. One participant commented*: "It is becoming very labour intensive and resources are scarce*".

d) *Contrasting with GM's implementation strategy*

In contrast to Delta's strategy, GM typically has entire departments of IT specialists focused solely on system implementations, and they undertake a formal structured approach to the implementation. One respondent said: "…*but right now it is just a small group. This is totally contrary to what is happening in the General Motors environment where they have a full-on department with huge resources".*

5.3 ANALYSE YOUR REQUIREMENTS

The more effective the requirement analysis process, the greater chance there is of the system ultimately fulfilling company needs.

5.3.1 System requirements not adequately determined up front

In Delta's case, some respondents felt that system requirements were not adequately determined at the outset of the implementation due to a lack of in-depth understanding of the system capabilities.

a) *Lack of detailed business analysis*

One respondent commented: "A detailed investigation was not done" and another said: "*so we took an existing system with an understanding that it would meet our requirements*".

b) Lack of in-depth understanding of system

One participant said: "*The skill level was lacking from our side because we were not sure how iMAN works".*

5.3.2 The moving goal-posts

Due to the fact that some needs became evident later in the implementation process, such as additional software licences, these issues became stumbling blocks which delayed the implementation process.

a) *Needs became evident over time*
One respondent said: "…*as we expanded our knowledge base of iMAN we realised that the needs and requirements for managing the data were met*".

b) *Software tools inadequate*
Due to the limited financial approval given for the project, only five licences were initially available. One respondent said: "*We did however have a problem justifying the tangible benefits or payback of the R1,2 million, so we went in with phase 1 which cost around R250,000".* After acquiring the GM Toolkit application in order to assist in the standardisation of data in line with GM standards, it was found that additional licensing was required for Unigraphics to interact with this software.

5.4 JUSTIFY THE COST

For senior management, it all came down to the cost: "*Firstly they look at cost. You have to convince them of cost vs. quality. Then you have to convince them of the benefits of the money being spent…".*

5.4.1 The bottom line approach

a) *Payback versus strategic competitive advantage*
The management approval process revolved around tangible payback from the financial investment, instead of recognising and understanding the strategic advantage of a leaner, more efficient organisation, which would lead to greater competitive advantage in the marketplace. One participant said: "*It is very difficult to sell*

someone a software package without seeing tangible returns on investment…".

5.4.2 Tangible versus intangible benefits

a) *CAD data management*

Effective data management has many benefits which cannot always be measured, such as greater efficiency, lower frustration levels of employees, greater sense of job satisfaction, fewer mistakes, better access to information and being able to see visual representations of the components, instead of text and numbers. One participant said: "…*although a lot of the benefits can be measured, many of them cannot be measured*".

b) *Productivity improvements*

Although productivity can be quantified in terms of time taken to complete certain activities, an organised and effective system provides productivity benefits far beyond these as an integral part of daily life. One respondent said: "*The intangibles, for example the enjoyment engineers may get working within an electronic environment, the opportunity of being creative, which stimulates his job interest cannot be measured in Rands and Cents".*

c) *Cost of errors*

Some errors incur repair costs but others are rectified without any measurable losses. Time wastage, inaccuracy and frustration levels are typical results of errors. One respondent said: *"…if we miss an engineering change and tooling is involved, this could easily cost from R300,000 to R1 million*".

d) *High-risk product programmes*

Most product programs are timed strategically around the introduction of competitor products, and unnecessary delays due to inefficiencies and errors could mean a loss of competitive advantage in the marketplace. One participant said: "*We were* *running into new programs and the risk was very high*".

5.4.3 Conditional approval

a) *Approval of first of three phases of implementation*

One respondent said*: "because of the high cost and the immediate benefit not being realised, management agreed to give us the funds to implement phase 1 which is the drawing office implementation*". Limited approval was then provided along with the funding required for phase 1. The message from senior management was therefore that the data management crisis had been recognised and required addressing, but from a strategic perspective they were not prepared to invest in the greater intangible benefits of Product Data Management beyond the drawing office.

b) *Onus on user department to demonstrate success*

The proviso for further investment in phase 2 and 3 was that engineering demonstrate the benefits gained from the first phase of implementation.

5.5 SELECT A VENDOR

The software and vendor selection process was straightforward due to the requirement of following GM systems and the limited channel for availability of the appropriate software in South Africa.

5.5.1 Software dictated by GM

One respondent commented: "*We did not want to re-invent the wheel. Although we are a SAP based company, to get a SAP PDM to be integrated with Unigraphics would mean driving it through an interface which would not be ideal, and we therefore decided to do what GM is doing. They have done all the homework and we agreed that iMAN would be the best bet".*

5.5.2 Software vendor dictated by local licensing agreements

One participant said: ”*We (software vendor) are the sole suppliers in South Africa of this specific software. We represent EDS and that is the reason why no other companies were identified in South Africa*”.

5.6 DESIGN THE SYSTEM

Very limited configuration was required for phase one implementation at Delta as Teamcenter Engineering is designed to be an out-of-the-box installation covering most users’ initial needs.

5.6.1 Standard system implementation - no customisation

One respondent explained: “*Phase 1 is very limited on configuration. You have the capability of configuring the system to a specific company’s needs, but that is mainly on phase 2 and phase 3 when you start interfacing with current systems, typically with MRP systems and workflow and change management which needs to interface with systems like SAP and current document management systems. Luckily due to integration with the CAD system currently used at Delta, the available software gave the best Unigraphics integration possible”*.

5.6.2 GM Toolkit

The GM Toolkit is a customisation developed by GM through EDS with the purpose of ensuring CAD data format and configuration standards globally for GM plants and their suppliers. This standardisation allows easier data flow between plants and suppliers during the development process and reduces system conflicts between sites. One respondent said: “…*we looked at the GM toolkit which requires a vast amount of information added when the drawing is constructed*”. Although the GM Toolkit was procured by Delta, it has not been introduced as yet due to additional licensing issues. Once these are resolved, the designers need to familiarise themselves with the methodology in order to gain the benefits of working with this software.

5.7 PLAN THE IMPLEMENTATION

A three-phase implementation plan, which broke the complex process down into manageable steps, was presented to management. Phase 1 was approved and phase 2 will be presented to management before the end of 2003.

5.7.1 Phase 1: Drawing Office

The drawing office implementation phase consisted of the following elements.

- All CAD files to be designed and managed in Teamcenter Engineering.
- Drawing revision levels to be managed in Teamcenter Engineering, replacing the manual card system.
- Completed local designs to be released in Teamcenter Engineering after sign-off and release by the engineer.
- All relevant legacy CAD data to be transferred from network drives into Teamcenter Engineering database.
- Legacy CAD data to be assigned the correct release level as per manual card system.

One participant commented as follows: *"…the drawing office was the main area that had to have iMAN installed because of the backlog of designs being done locally and from source plant".*

5.7.2 Phase 2: Engineering Department

Phase 2 consisted of the roll-out of Teamcenter Engineering to the wider engineering environment. This included the introduction of workflow for electronic sign-off of drawings by engineers, as well as the ability to electronically access and visualise all CAD data.

One respondent said: "*The next key factor for us is rolling out iMAN into the engineering environment. By doing this we can meet the objective of approving all our drawings via workflow with iMAN. This will give us a total level of confidence as to what information is released and what is not. It will also give engineers a lot of access to BOMs within assemblies and will also enable* *engineers to view the drawings in 2D and 3D format from their desktop. They will be able to do measurements and other functions with these drawings".*

5.7.3 Phase 3: Rollout to downstream departments and suppliers

Phase 3 includes giving access to Purchasing, Supplier Quality and Development and Manufacturing departments, as well as the introduction of a web interface for Delta suppliers. One respondent said: "*The third phase we are looking at is rolling the whole plan out to the company because there are many other areas who need to interact, such as Metrology who now have measuring cells within the laboratories and manufacturing. The same goes for Tooling and Tool Planning departments, to ensure that they have access to the correct information".*

Unfortunately, although the three-phase plan was presented to management, some of the implementation team felt that the plan for phase 1 was not adequately detailed and activities occurred in a haphazard manner. One respondent said: "*We just did it! There was no layout of the work to be done. Next time we will probably do it a bit better*".

5.8 ENSURE SUCCESS

A consistent and concerted effort is required to maintain momentum against various forms of resistance and roadblocks. Some of these issues are highlighted below, giving an insight into the reasons for the length of time taken to implement phase 1.

5.8.1 Software licensing and limited access

A previously mentioned, phase 1 provided only five Teamcenter Engineering "seats" or licences, thereby limiting access to only the drawing office designers. This prevented more widespread access that could have demonstrated benefits sooner and sped-up other implementation issues. One participant commented: "…*because of the high cost and the immediate benefit not being realised,* *management agreed to give us the funds to implement phase 1 which is the drawing office implementation*".

5.8.2 Hardware limitations

Hardware requirements are typically budgeted for on an annual basis and many old level computers (Pentium 1) still exist within engineering and the drawing office. Faster computers are slowly being added to the department to replace Pentium 1 and 2 machines, and at present approximately half of engineering staff have Pentium 4 machines. This affects the phase 2 roll-out strategy, as the older computers are not compatible with the Teamcenter Engineering portal software. Desktop hardware requirements have not been part of the Teamcenter Engineering implementation project costs.
One respondent said: "*The main issue we have in hardware is that we have to ensure that whatever level of software we have on machines, these machines have to be capable of working with the software. They have to have decent hardware to open up and view 2D information and 3D models. We will always have up to date software. However with regard to hardware, we try and project our needs to our IT department and hopefully they can during the course of 12 months ensure that a higher level (at least Pentium 4), is on all the engineer's desks. This has still not been achieved*".

5.8.3 Volume of legacy CAD data

At the last count approximately 35 000 files exist on Delta's network drives and require importing into the Teamcenter Engineering database. The importation process cannot be done on a batch-run process unfortunately, as each individual design assembly must be opened and checked for errors to ensure data integrity. This is a mammoth task, which will require support from all involved to speed-up the process.

5.8.4 Carrying over release levels

The release level of current drawings is controlled by a manual card based system. Many versions of source plant components are sent to Delta, as the vehicle design evolves. Delta does not release every source-plant change, but rather leaves the decision up to the responsible engineer to investigate the implications on local tooling or manufacturing processes. Once the decision is made, the applicable card is updated to show whether the newest version of the design is released for Delta production or not. Every design imported into Teamcenter Engineering therefore needs to reflect the correct release level shown on the card in order to maintain design integrity and production continuity. This arduous task needs to be performed before the release levels in Teamcenter Engineering can be trusted and the old system made obsolete.

5.8.5 Resistance to change

Due to the significant revolution in the work procedures required by the new PDM system, there has been a considerable resistance to the changeover. Each road-block has been seen as an excuse to delay implementation rather than overcome and learn from the experience. A lot of users have worked in their environments for many years and have grown accustomed to the old way of doing things. A considerable amount of time and effort was required to encourage users to eventually adopt and adapt to the new system.

5.9 MAINTAIN THE SYSTEM

System maintenance is crucial to the long-term success of a strategic PDM system. Three aspects of maintenance are discussed below, namely hardware maintenance, software maintenance and user training.

5.9.1 Hardware maintenance

The Teamcenter Engineering server is located in the IT server room, which is a secure fire-proof and air-conditioned area, and regular data backups are kept. As the Teamcenter Engineering database expands with data, and especially if the system is used by outside departments, additional hard disc space may need to be added to the server, which has the capacity to receive additional drives.

One participant commented as follows: “Data backup is done by IT daily, weekly, monthly and six monthly. Anything that is lost can be retrieved. The server is separated from the back up…”.

5.9.2 Software maintenance

Software updates are achieved through a maintenance contract set up with the software vendor. Any new versions are therefore automatically made available to Delta, but are usually timed to coincide with GM software version upgrades. One user said: “*Because of the maintenance agreement we have with Esteq if there are any updates in iMAN we will receive updates from them…”.*

5.9.3 User training

The software vendor has provided user training for all drawing office staff and database administrators. Any further user training can be provided by the software vendor, or one of the Delta users with the appropriate experience. One of the participants said: “…we are available for on the job training and also do upgrade training and we handle the upgrade of software every year”.

5.10 CHAPTER SUMMARY

The participants interviewed during this study provided the researcher with a broad perspective of the implementation process, while the disparate responses to the interview questions illustrated the differing perceptions of each participant.

The chapter that follows, analyses and categorises the above results in order to determine the key issues, both positive and negative, that influenced the outcome of the implementation process.

CHAPTER 6
CONCLUSION AND RECOMMENDATIONS

An analysis of the results and discussion of the data gathered, clearly shows a few key issues that affected the implementation process of Teamcenter Engineering in a fundamental way. Some of these issues are rooted deeply in the organisation culture and management style within Delta Motor Corporation. However many of these issues can be addressed through careful planning, and a clear understanding of both the technical and organisational requirements for a successful system implementation process.

6.1 PHASE 1 IMPLEMENTATION: KEY ISSUES

6.1.1 Identifying Needs

System and organisational needs were identified as a result of a growing crisis relating to electronic data management within the engineering design environment at Delta. This process did not occur as a result of a strategic company-wide information system plan, which showed how the company should be making best use of technology to improve efficiency, productivity and reduce product development time to market. A problem became apparent and a solution was sought to best deal with it.

The positive aspect of the crisis-driven approach is that a strong driving force is created for change implementation, which increases the probability of a successful outcome. The negative side is that the crisis tends to focus the organisation too closely on the problem at hand, thereby sacrificing a detailed, broad-based needs analysis during the planning stages of system implementation. The result of this approach being that additional needs tend to become apparent over time, causing frustration and delays during implementation.

6.1.2 Gaining Support

Company support for this system and its implementation was sorely lacking both financially and morally. This resulted in an uphill battle in many areas that required the involvement of parties outside of the engineering environment, which resulted in delays and frustration.

Good support within the engineering department existed, where the need was most evident, but engineering was left out on a limb as far as information technology support was concerned.

A definite gap existed in the implementation team, for someone to take ownership and drive the implementation process from within. An implementation "champion" was needed who could get to grips with the detail, while maintaining a business perspective, and the existing staff did not seem to display the motivation or initiative required to meet this need.

6.1.3 Requirements analysis

A key shortcoming prior to implementation was a lack of detailed understanding of how Teamcenter Engineering would manage Delta's business processes. There were some people who understood the high-level business processes but not the system detail, and some who understood the system but not the business. There was also an expectation from Delta that the software vendor would do a lot more than simply install and set-up the system. This ultimately lead to a gap in the implementation strategy as there was no integration of business and system requirements.

6.1.4 Justifying the Cost

The success of the overall implementation of Teamcenter Engineering has been severely limited by a lack of funding. Not only was the software budget cut to a minimum, allowing only five licences to be used in the drawing office, but no funding was allocated to the cost of implementing the system. These costs would include paying consultants, typically the software vendor, to analyse and configure the system to suit Delta's business processes, additional training for implementation team members and visiting source plants to gain an insight into how their data is managed.

This lack of financial resources is indicative of the lack of long-term commitment by senior management to the strategic importance of Teamcenter Engineering.

6.1.5 The Implementation Plan

The overall three-phased implementation approach was good from a high-level management perspective, but the plan was lacking when it came to detail, timing and task accountability. Communication of the plan is vital and continuous monitoring of progress essential in order to meet targets.

6.2 RECOMMENDATIONS

Figure 6 below serves to illustrate recommendations for a successful implementation of phase 2, in terms of the experience gained during the implementation of Teamcenter Engineering phase 1.

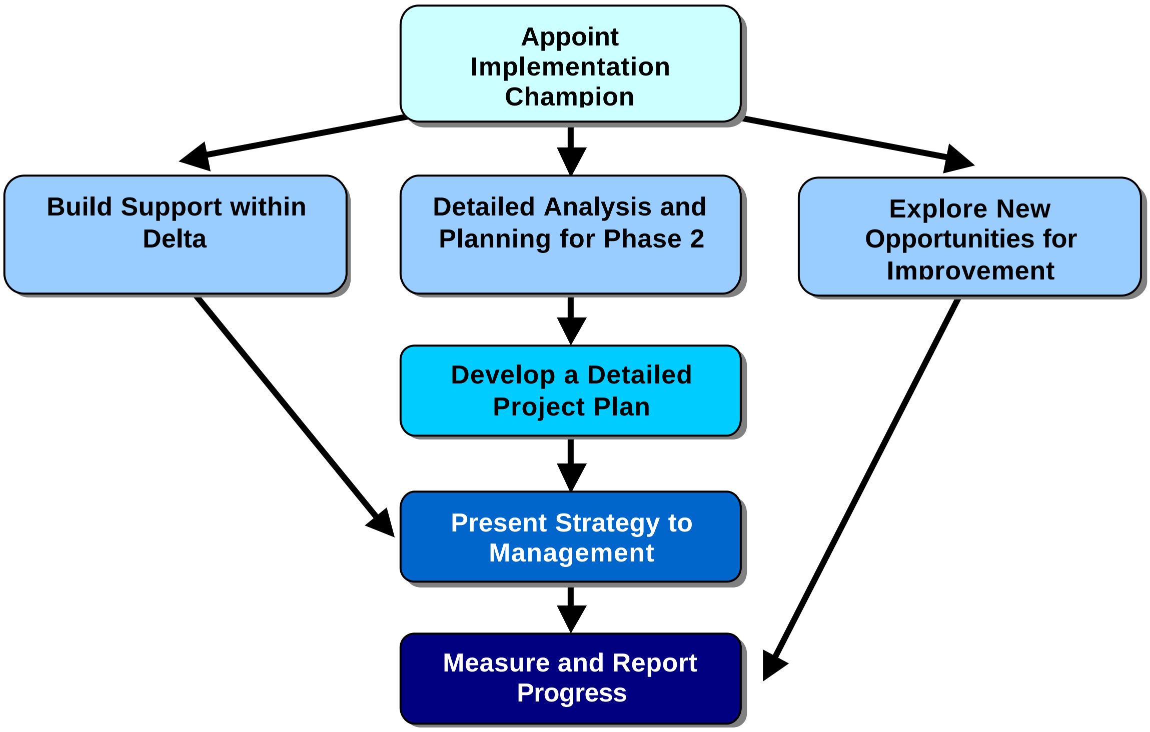

Figure 6: <u>Recommendations for Phase 2 Implementation</u>

6.2.1 Detailed Analysis and Planning for Phase 2

Phase 1 implementation served as a learning experience for all involved, and phase 2 is a chance to demonstrate the lessons learnt and produce a far more effective implementation project. Kotter in Kreitner, Kinicki and Buelens (2002:548) suggests that a strategic plan should be created to guide the project vision and Delta should conduct a detailed analysis of its business needs and processes to formulate this plan. Specific mention should be made of how Teamcenter Engineering will more effectively implement these processes.

Software and hardware needs must be built into the project to eliminate any further road-blocks in the implementation process and access should be as wide as possible. Performance matrices should be drawn up to facilitate realistic measurement of improvements in such areas as reduction in process times, greater productivity and elimination of errors.

Innovative change (Kreitner, Kinicki and Buelens 2002:544) is required during the phase 2 implementation as new processes and practices will be introduced. Careful planning should therefore be done around managing the organisational changes required.

6.2.2 Build Support within Delta

Kotter's fourth step in leading organisational change is communicating the change vision (Kreitner, Kinicki and Buelens 2002:548). Many departments within Delta will be impacted by Teamcenter Engineering and as much information sharing and discussion should take place as possible. Meetings and presentations need to be held with all affected departments to demonstrate the benefits to them and the company, and ultimately gain widespread support and knowledge of the system.

Every opportunity must be taken to inform, motivate and persuade personnel regarding the positive aspects of Teamcenter Engineering. Other departments should be encouraged to investigate the additional software solutions in the

Teamcenter range such as Teamcenter Manufacturing, in order to gain the synergies required to improve information flow throughout the company.

This is an important step in overcoming resistance to change, as widespread knowledge will be available by the time the system is implemented.

6.2.3 Present Comprehensive Implementation Strategy to Management

A comprehensive short and long-term strategy should be presented to senior management, demonstrating and quantifying the strategic benefits of implementing the system and correlating these to Delta's business plan. Laudon and Laudon's (2002:25) strategic business challenge should be emphasised, illustrating how Delta can use information technology to become competitive, effective and digitally enabled. Integration with General Motors' global information technology strategy should also be a key motivating factor.

6.2.4 Appoint Implementation Champion

The main role of an implementation champion is to drive the process through to successful implementation. The appointed person should be committed to ensuring that every effort is made to achieve the goals of the implementation and he should act as a public relations officer, promoting and marketing the system to users and interested parties. It is important that the person is properly trained and empowered within the organisation to be able to effect change in the face of resistance. Kotter's fifth step in leading organisational change is to empower broad-based action (Kreitner, Kinicki and Buelens 2002:548), and this could most effectively be achieved through the implementation champion. Opportunities for exposure to other similar installations such as at Delta's source plants, should be afforded to provide further insight and experience which would compress the learning curve and improve the quality of the final outcome.

6.2.5 Develop a Detailed Project Plan

Phase 2 should be carefully planned, while ensuring buy-in from those responsible for the plan. The plan should contain activities, timing and responsibilities for carrying them out, and regular reviews should be conducted with the relevant personnel to monitor and track progress. Refer to Appendix 5 for a copy of the Phase 2 implementation timing plan.

6.2.6 Measure and Report Progress

Progress must be measured against the plan and significant milestones reported on and publicised. Successfully completed activities should be publicised, and recognition given to those responsible, in order to demonstrate Kotter's "short-term wins" (Kreitner, Kinicki and Buelens 2002:548).

6.2.7 Explore New Opportunities for Improvement

Finally, no technology remains stagnant and new trends and better ways of doing things should be sought out and analysed for suitability within the local organisational environment. Many processes and systems exist for improving and speeding up business activities from document management to virtual prototyping and digital simulations, and a company should keep in touch with technology to maintain a competitive advantage in the marketplace.

6.3 CONCLUDING REMARKS

In conclusion, I believe that Teamcenter Engineering has a bright future at Delta and despite the shortcomings of the phase 1 implementation, many factors have since fallen into place to improve the prognosis for phase 2. Firstly, the researcher was appointed as implementation champion, and he has been integrally involved in the planning and analysis of phase 2 implementation. Various departments outside of the engineering environment have become aware and involved in Teamcenter Engineering and numerous presentations and meetings have assisted in this regard. The biggest hurdle still lies ahead however, and the final presentation to senior management for financial approval of phase 2 is planned to occur before the end of 2003.

Recent media announcements have confirmed that Delta is moving closer to full integration into the GM fold and this should make further resources available in the information technology arena in the near future.

On a personal note, this research dissertation has afforded the researcher the opportunity to formally analyse and research Product Data Management systems, as well as Delta's specific organisational mechanisms in a way that would not otherwise have been possible. It has provided a wealth of knowledge and insight that will assist in making this system implementation extremely successful and ultimately beneficial to the productivity and success of Delta Motor Corporation.

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INTERVIEW GUIDELINES

Trevor Stroud September 2003

Identify your needs

It is essential to be realistic about your needs and requirements as an organization and practical in how you will satisfy them.

1. *Were organizational needs identified before implementing this system?*
2. *How were these needs identified?*
3. *What needs or requirements did this system have to meet?*

Gain support

The right people must be involved in the process to gain a full understanding of how information flows throughout the company and where the biggest bottleneck areas exist.

4. *Was support gained for the project prior to implementation?*
5. *Who was involved in the approval of the project?*
6. *Who was involved in implementing the project?*

Analyse your requirements

A few meetings should be taken up purely with this step, but care must be taken not to stay too long in the analysis process as one can become side-tracked on trivial issues.

7. *Were the system requirements analysed?*
8. *How were they analysed?*

Justify the cost

In justifying the cost of the project, the focus should be on business requirements first, not technology, to demonstrate the practical benefits to be gained.

9. *What level of approval was required for the costs of the project?*

10. How was the cost of implementation justified to management?

Select a vendor

A list of vendors that offer potential solutions should be developed and evaluated. An evaluation methodology that fits your company's style and time frame should be selected.

11. Why was Teamcenter Engineering selected as the PDM of choice?
12. How was the software vendor selected?

Design the system

In conjunction with the vendor, the system needs to be customized to best fit your organization culture and processes.

13. Was the system configured around Delta's needs?
14. How was this achieved?

Plan the implementation

When implementing a project of this magnitude, the focus should be on incremental projects that scale up gradually over time.

15. Was the implementation process planned?
16. What key elements did the implementation plan contain?

Ensure success

17. What measures were taken to ensure the success of this project?
18. What measures were taken to facilitate the organizational change required?

Maintain the system

19. What maintenance plans were put in place to keep the system up to date?
20. What plans were put in place to develop the skill level of users?

Interview Response Analysis

Interview Questions	Participant A	Participant B	Participant C	Participant D
1 *Identify your needs*				
1 Were organizational needs identified before implementing this system?	Yes	Yes	Yes	Yes
2 How were these needs identified?	Evaluating current work processes Investigating source plant processes	Interviews with Ken Bartle Viewing current work processes	Practical experience with large volume of CAD data The need for single master CAD file	Hardware needs determined by checking software and database requirements
3 What needs or requirements did this system have to meet?	Uniformity with source plants/GM systems software Effectively manage large volumes of CAD data Cost effective solution Easy access to correct release level data Manage changes accurately	Interfacing with GM plants (Germany/Brazil) Managing CAD data within drawing office Controlling access to CAD data Sharing data outside drawing office	Manage large volume of CAD files Retain single master CAD file per design Disseminate CAD data efficiently to down-stream departments	Stable database system Low system maintenance requirements Good back-up system Stable operating system
2 *Gain support*				
4 Was support gained for the project prior to implementation?	Yes - partially	Yes	Yes - Esteq	Yes - Esteq
5 Who was involved in the approval of the project?	Engineering Management Board of Directors	Management level	Ken Bartle was the driving force	Ken Bartle Guy Vellacot (IT Department)
6 Who was involved in implementing the project?	Ken Bartle - Team leader Trevor Stroud Jacques van Deventer Deva Ramasamy Kenny Ramasamy Bernard Schultz (scarce resources unlike GM)	Rudolph de Kock Jacques Mostert - technical support John Armstrong Cobus Oosthuizen Jacques van Deventer Deva Ramasamy Kenny Ramasamy	Esteq Jacques van Deventer	John Armstrong - Esteq Tim Niekerk - IT Craig Birch - IT
3 *Analyse your requirements*				
7 Were the system requirements analysed?	No - developed over time	No - no detailed investigation done	Yes	Yes
8 How were they analysed?	Requirements developed over time as experience grew	CAD requirements discussed during on-site training	Requirements determined by Ken Bartle	Requirements determined by Ken Bartle
4 *Justify the cost*				
9 What level of approval was required for the costs of the project?	Board of Directors Minimum of Managing Director approval	Not sure - not involved	Ken Bartle John Sadler Directors	Director level
10 How was the cost of implementation justified to management?	Implementation in 3 phases CAD data management requirements Cost of tooling changes for mistakes Running new high-risk programmes	No involved	No idea	Ken explained benefits and cost savings to John Sadler

5 Select a vendor

11 Why was Teamcenter Engineering selected as the PDM of choice?	Follow GM systems	GM standard system	Follow GM	Track record of iMAN in South Africa
	GM already went through selection process SAP based PDM not ideal due to poor integration with Unigraphics	Functional requirements met		
12 How was the software vendor selected?	Esteq is only vendor in South Africa for Unigraphics and iMAN software from EDS	Esteq is sole supplier in Africa	Esteq is only supplier of software in South Africa	Supplier of iMAN Track record of other similar implementations

6 Design the system

13 Was the system configured around Delta's needs?	No - standard implementation except for GM Toolkit	No - standard implementation for Phase 1	No customisation except for the GM Toolkit	Yes
14 How was this achieved?	GM Toolkit	-	GM Toolkit	Firewalls, backups etc.

7 Plan the implementation

15 Was the implementation process planned?	Yes - 3 Phases	Yes	No planning	No planning
16 What key elements did the implementation plan contain?	Phase 1- Drawing Office, Phase 2 - Engineering, Phase 3 - Roll-out to rest of the company	3 Phases	-	-

8 Ensure success

17 What measures were taken to ensure the success of this project?	Facilitated organisational change	-	Continuous liasing with Esteq	Not yet successful with implementation
18 What measures were taken to facilitate the organizational change required?	Convinced people of the benefits Communicated regarding implementation Better working environment created	-	Don't know	Don't know

9 Maintain the system

19 What maintenance plans were put in place to keep the system up to date?	Software maintenance contract with Esteq Hardware annual budget	Software contract	Maintenance agreement with Esteq for software updates	Data backup by IT Esteq maintenance contract for updates
20 What plans were put in place to develop the skill level of users?	Training courses	Training	On the job training Training courses at Esteq	Training courses on software

General Motors

Global Engineering Integrator

process & systems integration program

RDV SPECIAL EDITION

Information Technology Support for GM's Math-Based Design Initiatives

RDV— A GAME CHANGER

What is Repeatable Digital Validation and how does it work?

Repeatable Digital Validation (RDV) is one of the keys to General Motor's goal of an 18-month vehicle development time. Integrating a number of cutting-edge technologies, including data management and visualization tools, RDV will make it much easier for designers and engineers to collaborate on the development of powertrain systems, individual components or entire vehicles.

But what is RDV and how will it work? RDV is a process that integrates digital representations of products into GM's business processes to increase the rate of internal communication, learning and decision making. RDV means repeatedly validating the fit, form and function of a digital model.

Underlying this process are several interdependent sub-processes:

- Product Structure and Data Vaulting
- Configuration
- Visualization
- Analysis
- Tracking

Each of these sub-processes, while significant in their own right, are part of the larger RDV cycle, adding value to every step of the design, engineering, and manufacturing process.

Product Structure and Data Vaulting involves establishing data structures and linkages during Electronic Vehicle Assembly (EVA), and vaulting and managing the data. In other words, the geometric product data are given contextual meaning and value based on the other data it's linked to, whether that data consists of other geometric configurations or the text-based data contained in the Global Product Description System (GPDS) database. The structured data are then vaulted and managed in IMAN for future configuration use. (See Figure 1 for a list of RDV Structure and Vaulting Capabilities.)

Configuration is the sub-process by which specified linked and structured data are brought together for virtual assembly of any specific vehicle variant. Integration of IMAN with GPDS part usage and option information gives geometry in IMAN contextual and use-specific intelligence. (See Figure 2 for a list of RDV Configuration Capabilities.)

RDV STRUCTURE AND VAULTING CAPABILITIES

- Electronic Vehicle Assembly (EVA) will be put under IMAN control
- There will be a single EVA per program with configuration capability
- GPDS will be integrated with IMAN and UG to combine bills of materials, options and variant rules with geometry
- Manufacturing structured data will be linked with EVA
- Design-studio structured data will be linked with EVA
- Manufacturing and design-studio structures will be linked
- Security and backup measures will be taken to ensure the integrity of the vaulted data

Figure 1

Visualization is the dynamic viewing of the data after it has been configured. The primary tool for this will be Unigraphics' ProductVision, which allows users to view products or processes — whether in two or three dimensions — outside the CAD environment, even on a desktop PC or laptop.

Continued on Page 4

RDV CONFIGURATION CAPABILITIES

- GPDS, IMAN and UG will be integrated to provide configurable geometry to the design
- Most configurations will be relatively automatic and fast
- Predetermined views of configurations will support clear communication and rapid problem solving

Figure 2

RDV enables collaborative design, review, and design in context.

RDV — A CALL TO ARMS

Following the RDV road map

Organizations of all shapes and sizes are looking to technology to help them refine their business processes. General Motors is no exception.

Repeatable Digital Validation (RDV) is a prime example of this. RDV promises to cut both the time and the expense involved in GM's design, engineering, and manufacturing cycle, creating a leaner, process-oriented collaborative culture that will go a long way towards meeting the company's goal of an 18-month vehicle development time.

The current system of design and engineering, which involves the extensive use of physical builds, is effective, but not particularly efficient. It creates large, time-consuming loops of remediation, as problems are repeatedly posed, investigated, and then solved. This process, which progresses from the original Alpha Builds through Pilot Builds, results in a design and engineering cycle that doesn't follow the ideal time-and-cumulative-knowledge path toward vehicle completion (see Figure 1).

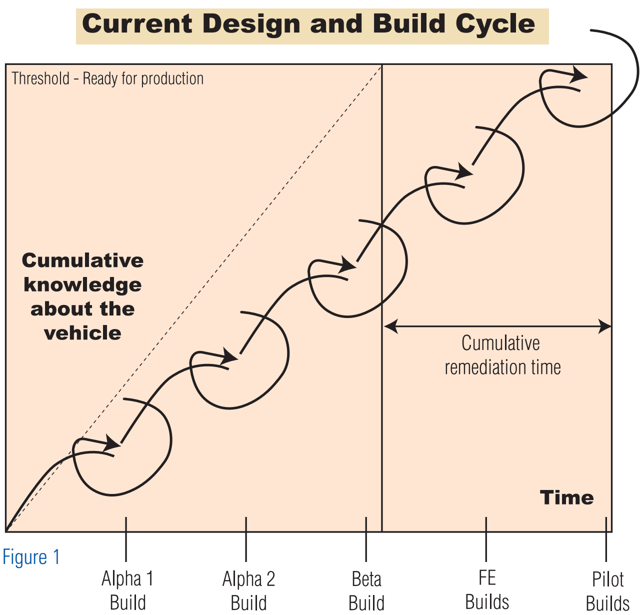


Figure 1

The use of RDV, however, promises to significantly shorten vehicle development time. Because the remediation process is constant and ongoing — thanks to the use of virtual models rather than physical builds — learning cycles are significantly reduced. As a result, the cumulative remediation time is reduced, and there is the potential to shave a substantial amount of development time from the final outcome (see Figure 2).

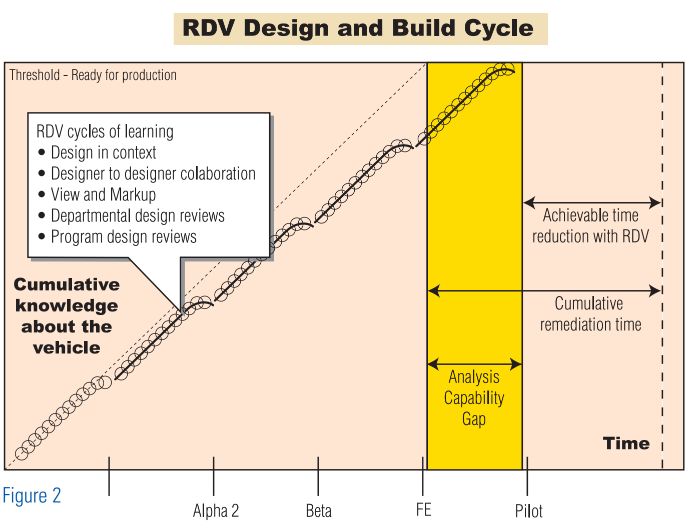


Figure 2

By eliminating time from the development cycle, a proportionate amount of money will also be saved. Similarly, reducing physical builds will also result in cost savings.

The implications of the overall RDV process are far-ranging, considering its potential to save both time and money. While the RDV process will mean changes in how design and engineering are accomplished, it shouldn't be seen as a departure from traditional approaches. RDV, in fact, enhances the entire process, cutting down on cycle times and the time-consuming approach to testing and validation currently used.

With that in mind, GM functional units involved in design, engineering, and manufacturing must gear up for RDV implementation, to smoothly transition to this new approach to vehicle development.

For example, the Vehicle Architecture and Integration/ Portfolio Development Center group will be assigned a number of RDV-specific tasks, such as making sure that a consensus on criteria structure and linkages to Electronic Vehicle Assembly (EVA) are developed and delivered to the EVA team.

The group must define common RDV data views, and also define RDV process scenarios including: design in context; view and mark-up; collaborative design; team and departmental reviews; supplier reviews; and management reviews. The group must get sign-off for the process changes from various engineering operations groups, including Car and Truck. The group must also integrate RDV sub-processes with Lean Engineering and prepare a functional RDV readiness plan for training, infrastructure, support, facilities, and budget.

Once GM's design and engineering community has followed similar RDV road maps, a leaner, more efficient design, engineering and manufacturing capability will emerge.

RDV CRITICAL SUCCESS FACTORS

- Senior executives in Engineering and Design Operations must assign key resources to define RDV processes for use in FAST VDP programs
- The core information model embodied in the Electronic Vehicle Assembly (EVA) structure must be robust and ready for use in a live program, starting in the Portfolio Development Center and continuing all the way through the Vehicle Engineering Center
- Design Services processes must be defined and implemented to ensure RDV geometric data is populated in EVA
- Engineering functional teams must define RDV process scenarios, roles, responsibilities, and result expectations, plus instruct their team members on how to execute RDV both within their function and collectively with other functions
- Every engineering functional group must develop and execute a readiness plan to ensure RDV use in upcoming programs
- RDV processes and sub-processes must be integrated into Lean Engineering
- Technology development must be completed on time for pilots and made production-ready for prime usage in real programs
- Infrastructure, including hardware, networks, distributed capability, product data management and integrated software, must be in place and validated for prime-time use in FAST programs
- Training programs must be developed, tested, and implemented in time to prepare users to incorporate RDV in FAST programs
- Engineering leadership of programs that will be the first to use RDV processes must develop program plans that visibly incorporate the new RDV processes
- A support plan with staffing must be established to shepherd the new RDV processes through the first program

PRODUCTVISION — THE NEXT GENERATION

The 2000 deployment of ProductVision Version 3.0 means a clear view for RDV

Think of ProductVision as a window to the virtual world. It allows users to tessellate and render Unigraphics math data as three-dimensional objects that can be viewed, cut into sections and checked for clearances.

As part of General Motors' Repeatable Digital Validation (RDV) process, ProductVision is probably the component that will get the most notice. It is, after all, one of the few parts of the process that people will actually be able to see.

ProductVision Version 1.1 is currently being deployed to GM's product development community. It allows non-Unigraphics users, Version 1.1's primary audience, to view virtual models outside the CAD environment. All they need is a desktop PC — or even a laptop — to run the software and view individual parts, very large assemblies, or even entire vehicle configurations.

Version 1.1, however, isn't integrated into the RDV process. Nor is it tightly coupled with Unigraphics or the IMAN Product Data Management (PDM) database. These issues will be resolved with the deployment of ProductVision Version 3.0, which will seamlessly integrate with IMAN and Unigraphics.

Along with this integration, Version 3.0 will also offer more functionality. Slated for rollout with the Unigraphics Version 16 upgrade, this next generation of ProductVision will be made available to both the 10,000 or so Unigraphics users worldwide, and to existing users of Version 1.1.

More robust than its predecessor, Version 3.0 is aimed at the hands-on design and engineering community. It will include both ProductVision Visualizer and ProductVision Mock-Up, the latter of which is used for design in context reviews. With the aid of Mock-Up, for example, users can take cross sections of parts, conduct interference checks and define clearance rules — making sure a rod doesn't cut through a brake pad, for example.

This ability to conduct more in-depth analysis, beyond viewing and measuring parts, is what makes Version 3.0 a more valuable and fundamental component of RDV. It will take the entire RDV process to the next level, allowing for a more seamless integration of the digital design and engineering process, from concept to completion.

The implementation of ProductVision Version 3.0 means the RDV process is well on its way to becoming a reality.

BRAWN AND BRAINS

IMAN is the Vehicle configuration management for RDV

Imagine a huge automotive parts bin with a jumble of pieces and components spilling over the top. Now try to imagine finding the part you need to complete an assembly. Aside from asking someone else to find the part for you, there's no easy way to do it.

Now imagine that all the parts are stored in a warehouse, placed neatly on shelves, and conveniently labeled and tagged. Imagine further that all you have to do is hit a button that sends a robot shooting down the appropriate aisle, where it picks the part, quickly delivers it to you, and presents it to you in its proper spatial position within the vehicle — along with all its neighboring parts.

That's the idea behind IMAN, the Product Data Management foundation for GM's future Repeatable Digital Validation (RDV) process. IMAN organizes all product-related data (such as product geometries, bills of materials and related documents) into a data repository, managing any changes and interactions that affect the data.

Currently, much of GM's non-geometric data is entered as text into the Global Product Description System (GPDS). Because GPDS and IMAN are fundamentally different, the trick is to create an interface between the two to associate part model option data to the appropriate geometric assembly, sub-assembly or part.

Integrating the two would allow the digitized geometric parts that already exist in the rules-based IMAN database to be mapped to specific GPDS attributes. Once mapped, users will be able to call up geometry based on their attributes, along with any associated materials to define how the part is used and

Continued on Page 4

RDV TRACKING CAPABILITIES

- Builds will need to be under version control at the vehicle, compartment, and systems levels; and in some cases, at lower levels when decisions are made based on a build that affects more than one party (for example, simple build view and mark-up involving engineers, purchasers, and suppliers)
- Analysis results will be linked to version builds through Product Data Management (PDM)

Figure 5

Digital Analysis Process (DAP) involving multiple people in a structured decision-making environment.

RDV— A GAME CHANGER

CONTINUED FROM PAGE 1

(See Figure 3 for a list of RDV Visualization Capabilities.)

Analysis involves the interrogation of the model, such as checking for interferences and fit. The main processes involved in this step are the Digital Analysis Process (DAP) and design in context. Whereas DAP is a staged process involving multiple people and structured decision making, design in context is done on a routine and frequent basis by the designer or engineer during the course of his or her work. Both of these methods allow designers and engineers to digitally validate electronic models without having to build physical prototypes. (See Figure 4 for a list of RDV Analysis Capabilities.)

Tracking will allow designers and engineers to keep up with the latest electronic model builds, note changes as they occur, and view the results of any prior analyses. (See Figure 5 for a list of RDV Tracking Capabilities.)

Rather than thinking of RDV as a tool, it should be thought of as a process, one that builds upon itself as vehicle design and engineering work toward completion. RDV will increase internal communications, invite collaborative effort, encourage problem-solving and significantly shorten the vehicle development time. In short, RDV is a game changer for GM, enhancing the way vehicles are designed, engineered and manufactured.

RDV VISUALIZATION CAPABILITIES

- Reviewing builds of all types will be pervasive at all levels of the organization
  - View and mark-up
  - Design in context
  - Compartments
  - Full vehicle
- Hardware and infrastructure configurations will support pervasive RDV
- Analysis at all levels will be triggered by, and against, digital validation builds
- Standard builds will enhance communication and rapid problem-solving
- ProductVision will make it easy to quickly present builds and interact with geometry
- Configurations will be easy to get, and fast to assemble and build

Figure 3

RDV ANALYSIS CAPABILITIES

- Fast builds at all levels will result in short problem-solving cycles associated with all levels of builds
  - View and mark-up
  - Design in context
  - Compartments
  - Full vehicle
- Visual reporting of analysis results will be a normal part of the process because it will be fast and easy to display, with Product Data Management (PDM) managing the versions
- The Digital Analysis Process (DAP) builds and prototype builds will look more alike and be coordinated
- The current five-event analysis will detect far fewer problems and, in many cases, act more like a confirmation

Figure 4

BRAWN AND BRAINS

CONTINUED FROM PAGE 3

in which situations (for example, a brake assembly that's used only on a particular four-wheel-drive platform). Users could now more easily search for and bring the right geometry to their desktops for viewing.

Mapping this GPDS data to IMAN required sitting down with a specifications analyst to determine how GPDS data-usage conditions would translate to IMAN rules, a technologically complex task.

Now, however, much of this usage-rule mapping has been completed, and a great deal of the mapping will be accomplished automatically. Also, there will still be occasions where new rules will have to be manually created and mismatches corrected.

In the first phase of the GPDS-IMAN integration — to be piloted in December by the Truck group in Pontiac — the transfer of the data from GPDS to IMAN will take place via nightly batch loads.

IMAN, with all its data-management muscle, is the brawn behind RDV. Now, thanks to a lot of hard work and talent, it's also becoming the brains.

—COMING SOON—
Systems Integration Program
PSIC Web Site
w/downloadable .pdf newsletter

Teamcenter™

Accelerating new product innovations through proven engineering collaboration

eds.com/plm

Teamcenter Engineering

The early stages of your product lifecycle are key to the success of your product portfolio. Teamcenter Engineering accelerates new product introductions while increasing the innovative capabilities of your engineering processes.

EDS

Business challenges

Today's market leaders compete on the basis of:

- Time to market
- Product cost
- Innovative content
- Available product options and product variants

To succeed in today's digital economy, you have to outperform your competitors at multiple levels.

But how do you accomplish this, when the product lifecycle you adopt to plan, design, deliver, and support your product offerings is more complex than ever?

How do you optimize your product lifecycle when your extended enterprise includes your own geographically dispersed operations, as well as the diverse operations of your suppliers, business allies, and trusted customers?

EDS believes that the early stages of your product lifecycle are key to the success of your product portfolio.

Conceptual design is crucial to the introduction of new ideas and breakthrough product innovation. Product design and design validation determine well over half of your development costs. Your design decisions invariably impact the downstream stages of your product lifecycle.

Introducing Teamcenter Engineering

With so much riding on the effective performance of the early stages of your product lifecycle, you need to establish sustainable competitive advantages in terms of your ability to:

- Integrate all of the designs created by your value chain to define a product's engineering content. *Bottom-line benefit:* reduces your product lifecycle costs.
- Synchronize the engineering processes that require the participation of your entire value chain; enable value chain participants to access all of the product information they need to get their jobs done effectively. *Bottom-line benefit:* compresses your product lifecycle.
- Enable all of your product-related teams to work together effectively – without regard to any member's physical location. *Bottom-line benefit*: leverages your global engineering resources more effectively.
- Establish product configurations that you can manage, track, and re-use across an entire product lifecycle – as well as across multiple product offerings. *Bottom-line benefit:* slashes your development costs.
- Accelerate product delivery by enabling your design teams to seamlessly collaborate with your manufacturing teams. *Bottom-line benefit:* enables you to be first to market with your product innovations.

To address these strategic issues, EDS offers Teamcenter Engineering – a proven multi-CAD engineering process management solution for multi-site product teams.

A crucial solution in EDS' market-leading Teamcenter portfolio, Teamcenter Engineering is especially adept at enabling product development teams and small-to-medium sized companies to improve the efficiency of the earliest stages of the product lifecycle.

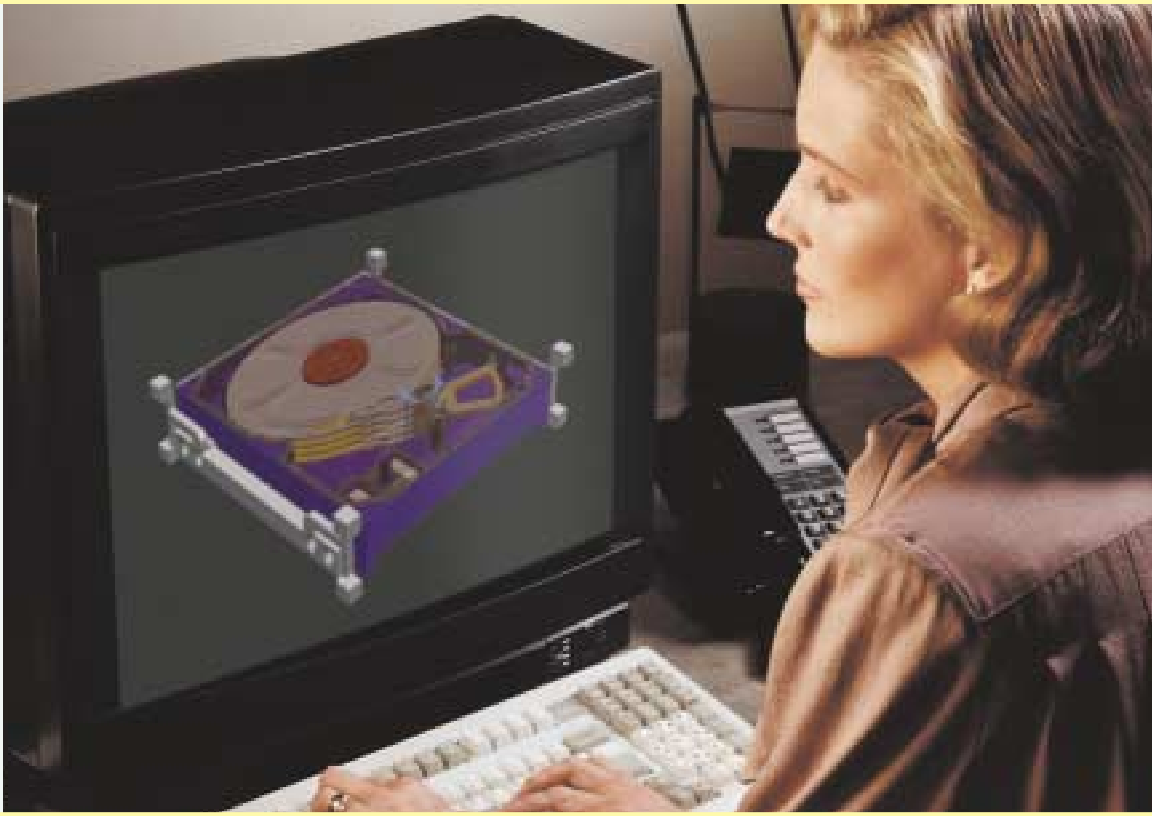
GETTING RESULTS

"Teamcenter Engineering is 18 months ahead of anyone in the industry with its leading systems model, and options and variant technologies."

Ed Miller
CIMdata

Teamcenter Engineering business value

Teamcenter Engineering accelerates the product lifecycle by enabling your take-to-market teams to streamline their engineering processes.



GETTING RESULTS

"Teamcenter Engineering offers world-class functionality in configuration management, variety management including generic product structures, collaborative CAD assembly modeling, top-down design, and configured digital mock-up…(providing) one of the most complete product definition solutions available today."

Wayne Collier
DH Brown

Teamcenter Engineering allows engineering and manufacturing teams to synchronize design data, share design models in workflow-driven processes, and collaborate across a fully digital environment. By combining these capabilities, your company can improve its product quality, reduce time and cost to manufacture, and accelerate your entire product lifecycle.

Teamcenter Engineering enables you to leverage your CAD investments in new processes by tightly integrating multiple, dissimilar CAD systems, including Unigraphics, Solid Edge, Pro/E, CATIA, and AutoCAD. Because Teamcenter Engineering provides you with a multi-CAD environment, all of the members of your take to market teams can view and understand the virtual product without having to learn how to use a CAD system.

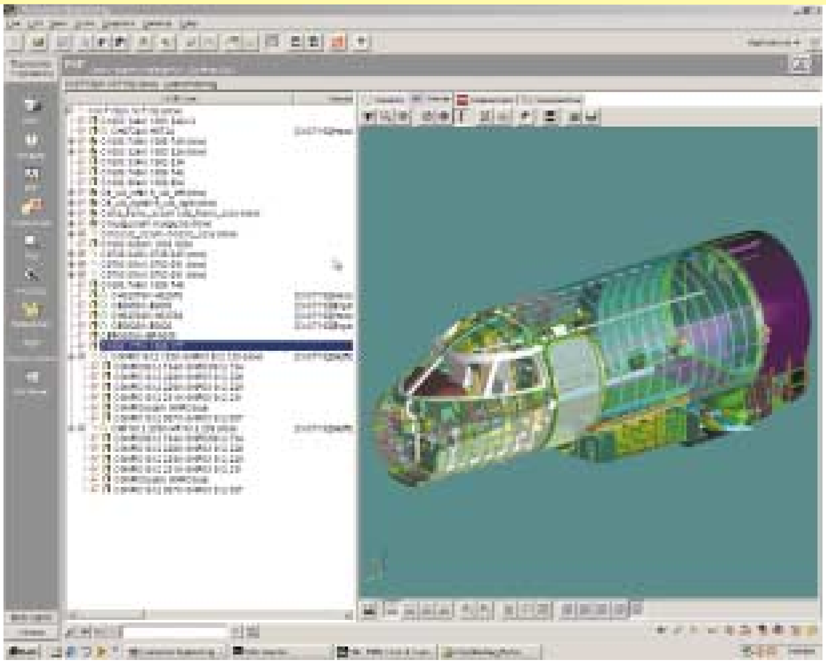
Teamcenter Engineering is the leader in multi-site collaboration and knowledge sharing – enabling you to federate your cooperating databases into a single logical system.

Teamcenter Engineering allows geographically dispersed product teams to collaborate in common design and team members to participate in automated engineering and manufacturing processes.

Teamcenter Engineering's integrated visualization capabilities improve communications among team members, as well as collaboration with other lifecycle teams. This enables you to inject more innovative design content into your products while ensuring that your design content is properly aligned and fully concurrent.

Teamcenter Engineering allows you to capture all of your product definition data and enables you to configure it so this information can be leveraged to automate and expedite your downstream product lifecycle processes.

By accelerating your product lifecycle, Teamcenter Engineering enables you to increase the number of products that you annually release to market and generate significantly more revenue from your product portfolio.



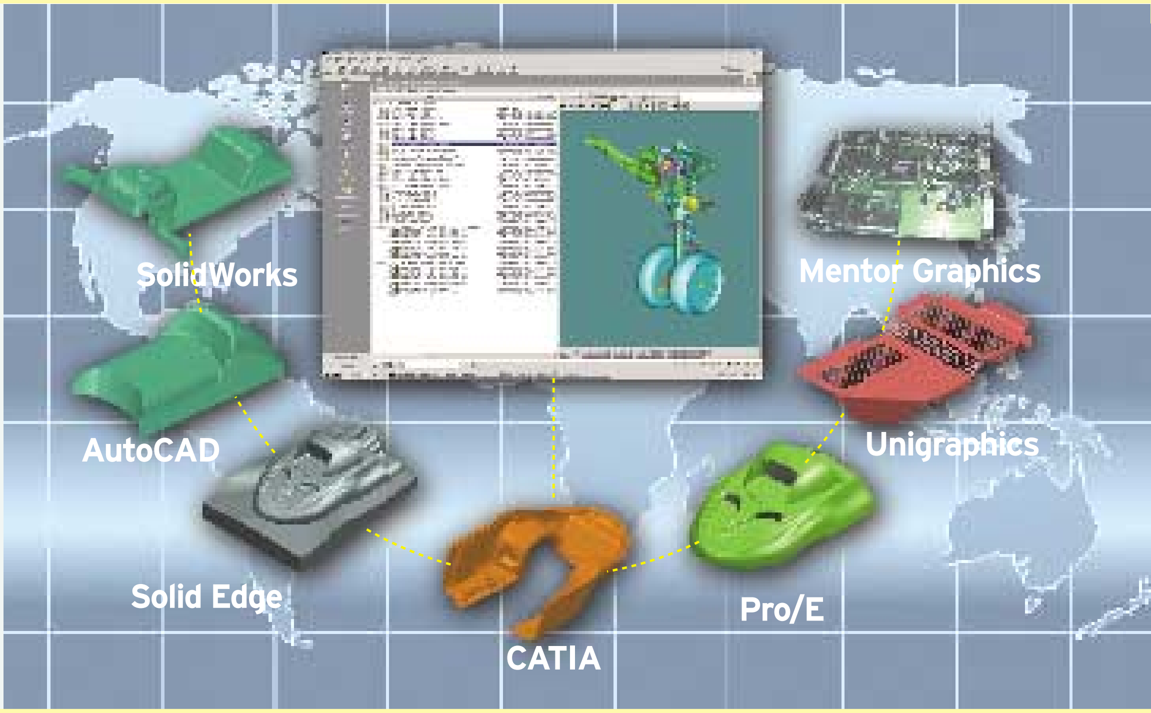
Teamcenter Engineering's benefits

- Optimizes early stages of product lifecycle that can determine up to 80 percent of your product cost.
- Increases product innovation and flexibility enabling you to target new markets.
- Increases design and manufacturing concurrency.
- Overcomes the barriers to communication among OEMs, suppliers, and their allied partners.
- Accelerates the introduction of new product offerings.
- Synchronizes the activities of globally dispersed teams.
- Catches costly design mistakes up front in your product lifecycle.
- Enables team members to securely access all information related to your product definitions.
- Ensures that everyone in your value chain is working from the same product assumptions.
- Leverages your value chain's most current CAD, CAM, and CAE investments into new processes.
- Enables you to extend your business value rapidly and seamlessly by adding other Teamcenter solutions while protecting your current investments.

Multi-CAD engineering collaboration

Teamcenter Engineering delivers five key capabilities to maximize the early stages in your product lifecycle.

- Multi-CAD engineering collaboration
- Engineering process management
- Multi-site collaboration
- Repeatable digital validation
- Unified product lifecycle management (PLM)



Teamcenter Engineering supports the tight integration of all major CAD systems, including Unigraphics, Solid Edge, Pro/E, CATIA, and AutoCAD.

Teamcenter Engineering's multi-CAD support reduces development costs while enabling your extended enterprise to leverage multiple CAD investments. State-of-the-market engineering collaboration must provide a multi-CAD environment that allows your cross-discipline design and manufacturing teams to seamlessly leverage design data created using any major CAD system.

Teamcenter Engineering meets this criteria by providing the only engineering product data management solution that supports multi-CAD data management in a single multi-purpose collaborative environment. This collaborative environment enables you to seamlessly leverage your integrated CAD data with the world's leading 3D product visualization and digital mockup capabilities.

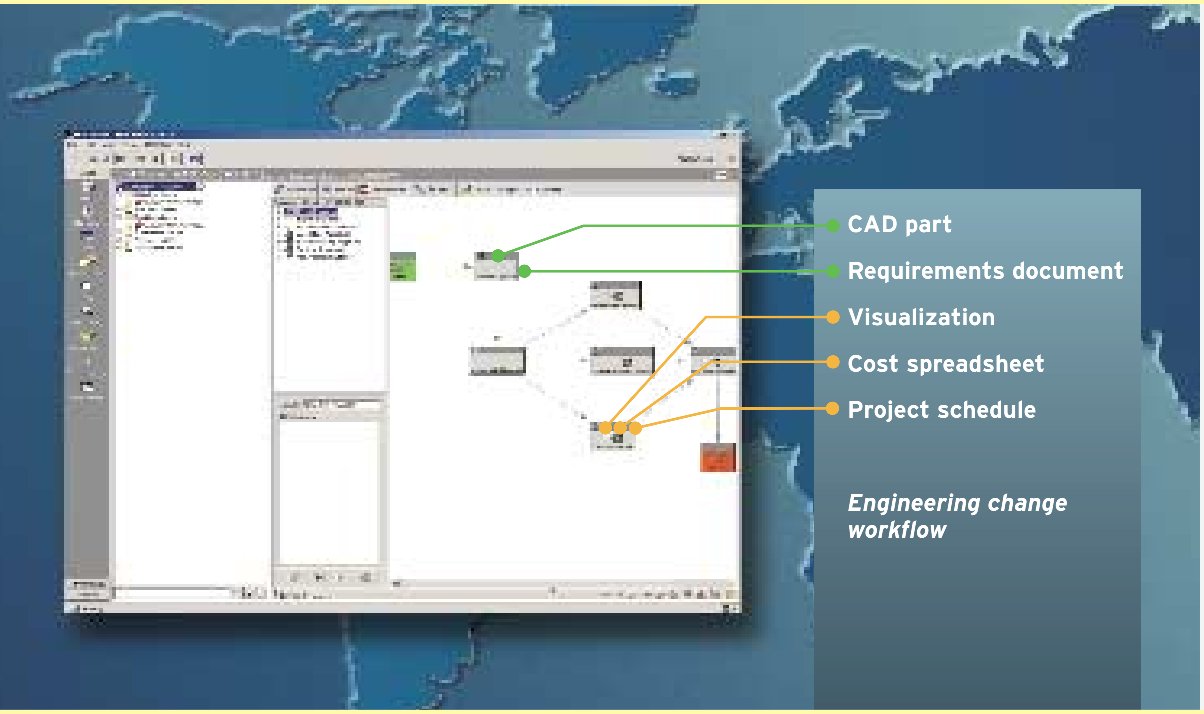
Teamcenter Engineering lets team members create and modify component designs on their native CAD systems (i.e., teams and/or individual team members continue to use their CAD system of choice) and publish their innovations/modifications in a collaborative environment when review is required by other teams/members.

Teamcenter Engineering automatically manages both native and neutral CAD representations to eliminate unnecessary translating delays. Equally important, this collaborative environment enables all teams and their members to access the most up-to-date product information available.

PRODUCT MAKERS ASK:

How can I integrate designs from multiple CAD systems into a common design process?

Engineering process management



Teamcenter Engineering provides engineering process management capabilities that streamline your product development processes while ensuring that you get the right product information to the right people at the right time.

Teamcenter Engineering's product structure allows you to manage all product information, not just CAD files.

Teamcenter Engineering streamlines product development cycle times by enabling teams to automate and synchronize their engineering processes. State-of-the-market engineering collaboration must ensure that all critical product information is delivered to the right team members at the right time. Engineering collaboration must enable entitled users to quickly locate the product knowledge they need to perform their jobs, while eliminating unwieldy information searches.

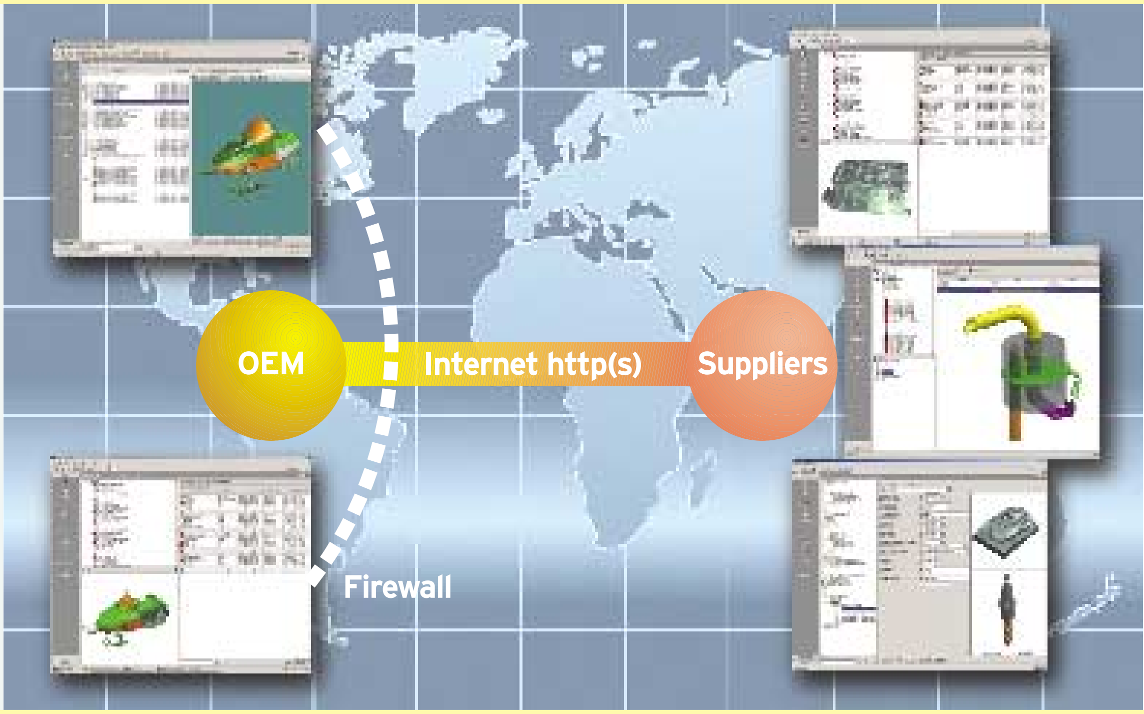
Teamcenter Engineering surpasses the capabilities of traditional CAD file management by capturing all relevant product and process information and relating these assets to a common product structure.

Teamcenter Engineering can manage all of your relevant CAD, CAM, and CAE information, as well as design specifications, documents, requirements, and other types of product-centric information.

Teamcenter Engineering's process management capabilities enable you to define engineering workflows that enforce company-specific business rules and efficiently execute your automated product-related processes.

Multi-site collaboration

Teamcenter Engineering enables multi-site, cross-discipline teams – including your suppliers and allied partners – to collaborate by leveraging your most current product information and accelerating your product releases to manufacturing.



Teamcenter Engineering leverages standards-based Internet technology to enable your extended enterprise to globally share engineering information across firewall boundaries.

By supporting multi-site collaboration, Teamcenter Engineering reduces product development costs and take-to-market cycle times by enabling engineering teams, allied partners, and suppliers to work seamlessly together in a virtual product-centric environment.

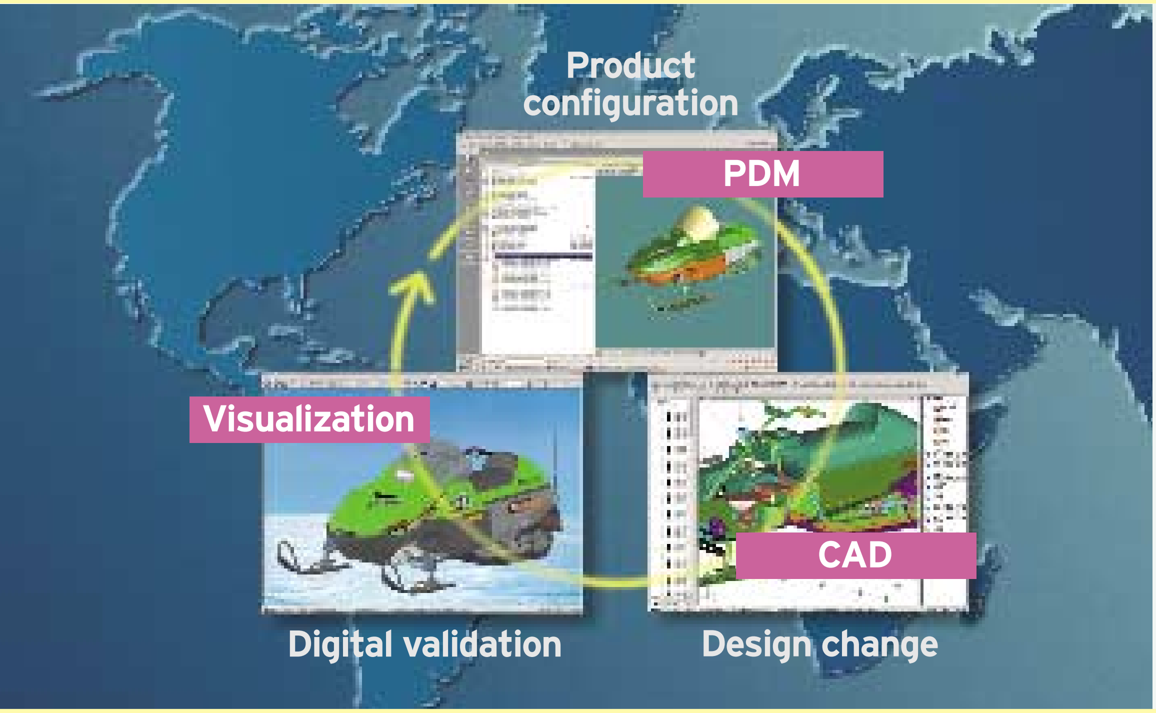
Teamcenter Engineering was built from the ground up to leverage the Internet for engineering collaboration. Designed to work across firewalls, Teamcenter Engineering enables all of your globally dispersed teams to share their product knowledge, align their design assumptions on a product-centric basis, and participate in automated engineering processes in a secure collaborative environment.

Team members can access Teamcenter Engineering at anytime from anywhere. They can employ virtually any kind of Web-accessible device, including mobile laptops, personal data assistants, and wireless phones. All entitled team members can access the same base of product information using familiar Web browsers, regardless of where they reside or what viewing devices they employ.

PRODUCT MAKERS ASK:

How can I synchronize my suppliers' design data into my internal development processes?

Repeatable digital validation



Repeatable digital validation is the next generation of digital mockup, where design validation is dynamically and continuously performed in the context of all design changes. Repeatable digital validation provides breakthrough technology that delivers substantial productivity gains.

Teamcenter Engineering enables all of the participants in your extended enterprise to seamlessly configure and validate the design content that goes into your new product offerings.

Teamcenter Engineering streamlines your product development processes and optimizes your product designs by enabling you to quickly configure, design, mockup, and validate your discretely manufactured product offerings in a unified collaborative environment.

Teamcenter Engineering is the world's first solution to provide a repeatable design-in-context process. Teamcenter Engineering unites industry-leading visualization, digital mockup, and 3D design solutions with product data management. This enables design teams and their members to access all product configurations and product knowledge that you retain under Teamcenter Engineering directly from your visualization and design solutions.

Teamcenter Engineering allows your teams to design and modify new components and assemblies while working in a multi-CAD digital mockup environment. Because Teamcenter Engineering's unified environment is designed for dynamic validation, you can automatically and repeatedly validate your design changes across all product configurations and their variants. This enables you to quickly understand the impact of these changes while ensuring design integrity across your product line.

By knowing something as simple as a single part number or change order, users can load everything for their design session from a small subset of parts to an entire assembly.

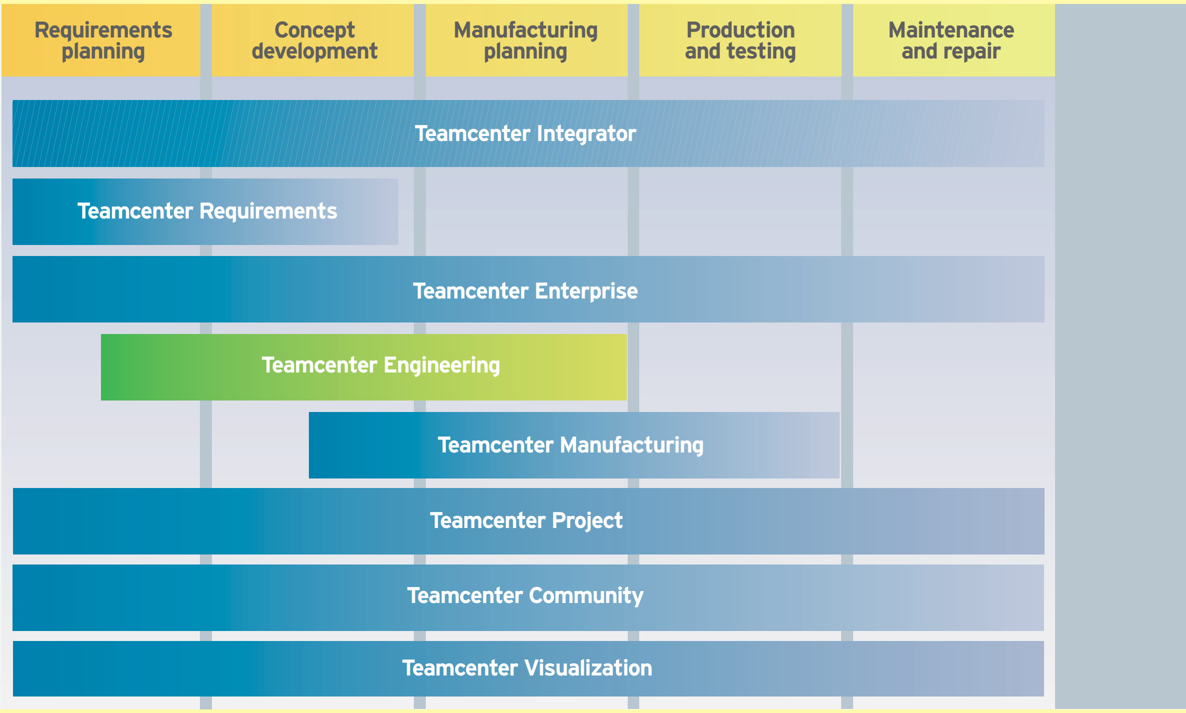
Advanced variant and option management capabilities make it easy for teams to develop new product versions or configurations for different markets. These capabilities maximize the re-use of your existing product knowledge. They provide a repeatable way for you to configure correct revision and version context while minimizing the amount of data loaded for your particular design session.

PRODUCT MAKERS ASK:

How can I accelerate design processes that involve the repeated use of similar product-configurations?

PLM unified

The Teamcenter portfolio leverages completely open, standards-based Web technology to transcend your enterprise's geographic, organizational, and technology boundaries.



The Teamcenter portfolio includes synergistic solutions that enable you to improve the effectiveness of your entire product lifecycle end-to-end.

The Teamcenter portfolio of PLM solutions enables you to extend the business value of engineering collaboration while protecting your current technology investment. Because Teamcenter Engineering is part of the Teamcenter portfolio of product lifecycle management solutions, you can rapidly and seamlessly extend the value of your engineering collaboration solution on demand. Teamcenter Engineering's open, standards-based architecture enables you to inject extended or alternative capabilities – offered by EDS or other software providers – into your collaborative environment.

Teamcenter Engineering's seamless integration with Teamcenter Manufacturing enables the frictionless flow of design/manufacturing information early in the product lifecycle. This helps eliminate engineering and manufacturing change orders that proliferate when poor communications and ineffective collaboration impact your product lifecycle. Teamcenter Engineering's ability to synchronize engineering and manufacturing BOMs across your product lifecycle reduces process inefficiencies, enabling you to accelerate the introduction of new products.

You can implement other Teamcenter solutions incrementally, as demanded by the priorities of your business. For example, to gain an immediate return on your investment, you can add Teamcenter Community to support ad-hoc conferencing and allow team members to perform real-time design reviews over the Internet.

In addition, you can extend the value of your Teamcenter Engineering investment upstream by implementing Teamcenter Requirements. This systems approach to requirements management introduces the discipline needed to align complex requirements with complex design content across a complete lifecycle.

Key capabilities

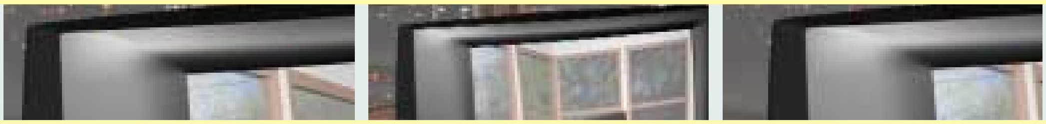
Teamcenter Engineering's robust capabilities provide all of the functionality that your engineering teams, allied partners, and suppliers need to collaborate on a global basis and maximize the efficiency of your product development processes.

These capabilities enable you to deliver new and more innovative products faster than your competition, while minimizing your costs and improving the productivity of your entire extended enterprise.

Teamcenter Engineering capabilities

Capabilities	Benefits
✓ *Advanced security*	Protects your mission-critical product information by applying best-practice access rules
✓ *Global access*	Enables you to establish engineering and manufacturing teams and perform knowledge sharing in a distributed multi-site environment
✓ *Complete search and retrieval*	Enables users to quickly locate component, part, and product information that appears in both graphic and textual formats
✓ *Managed check-in/check-out*	Protects the integrity of your engineering product information by "locking out" work in progress
✓ *Revision/version control*	Manages information changes by establishing revisions and intermediate versions
✓ *Friendly part/assembly configuration management*	Enables you to build and configure hierarchical product structures that are "intuitively" controlled
✓ *Comprehensive document management*	Manages documents, specifications, and other non-graphic information assets related to a defined product structure
✓ *Optimal process management*	Manages work in progress by leveraging state-of-the-art engineering change management
✓ *Visual engineering change management*	Provides early visibility to change impact and an overall view to your product change history
✓ *Embedded visualization*	Enables users to dynamically view 2D and 3D virtual products, including design data created under multiple CAD systems
✓ *Digital mockup verification*	Digitally validates high-level product configurations
✓ *Repeatable digital validation*	Enables users to configure and validate high-level multi-CAD product designs in a unified Web-native environment
✓ *Part classification*	Enables users to classify, locate, and re-use existing parts and tools during the product development process
✓ *Advanced product configuration*	Manages product options, variants, alternatives, and multiple views to bills of materials (BOMs)
✓ *Easy view and mark up*	Provides users with multiple ways to access product information during review processes, including supporting the world's premier solution for visual collaboration

Customer success: Production proven for your multi-CAD environment



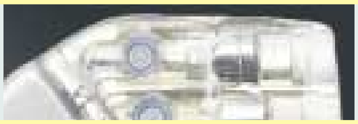
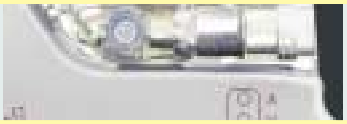
LG Electronics, a leader in the Korean electronics industry, makes high-end, future-oriented products. Its products include flat panel LCD monitors, CD-ROM and DVD-ROM drives, and home appliances, such as intelligent air conditioners, dehumidifiers, and microwave ovens.

The company uses Teamcenter Engineering to integrate all of its product development information, including connecting related legacy systems without regard to their physical location or time zone. LG Electronics leverages Teamcenter Engineering to manage project information, documents and drawings, EBOM/MBOM specifications, and electronic examination and approvals.

Teamcenter Engineering is the nerve center for LG Electronics' planned Web-based development environment, which includes overseas factories, C4 integration, and SCM interface. LG Electronics has successfully employed Teamcenter Engineering to improve design quality and more efficiently utilize its product knowledge.

The bottom line impact of Teamcenter Engineering has been particularly strong. Development costs have been reduced by $450,000 a year. Design errors have been reduced by 80 percent. And the time from EBOM to MBOM has been reduced to 3 hours from 32 hours.

Customer success: Small/medium technical enterprises

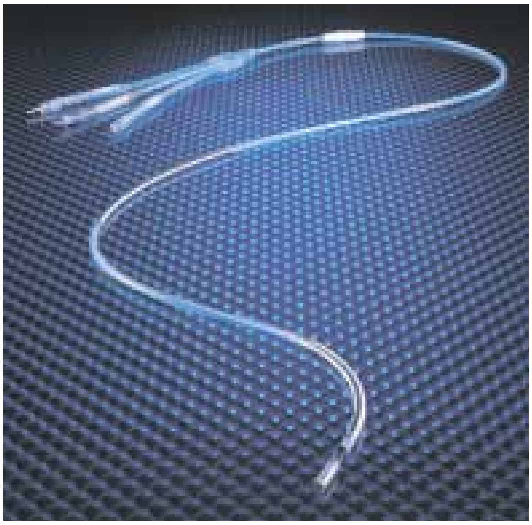




The Cardiac Rhythm Management Division (CRMD) of St. Jude Medical — a global manufacturer and distributor of pacing technology products — selected Teamcenter Engineering because of its proven technology in a production-ready environment. EDS' ability to implement this solution within the required time frame was also important.

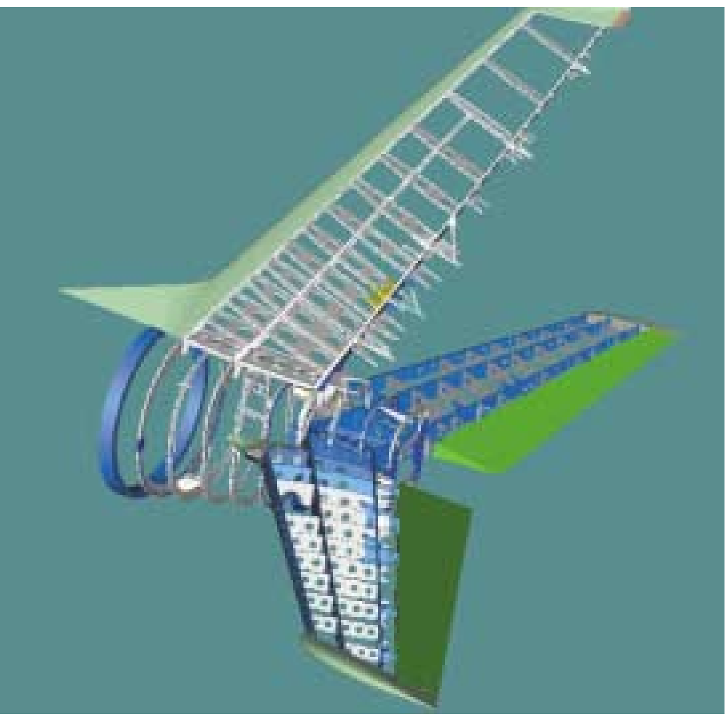
Like many small-to-medium sized companies, St. Jude Medical's core lifecycle processes supports its technical teams. St. Jude Medical was especially impressed with Teamcenter Engineering's ability to manage fine-grain product knowledge, such as the geometric relationships typically used by technically focused product teams.

"We are excited that with this partnership we can further improve our business processes, especially in the areas of collaboration of new product development and manufacturing across all of our facilities," says Ben Khosravi, CRMD's vice president of Quality Assurance.

"Teamcenter Engineering will be the primary facilitator of our product data management system and provide the vehicle for unified access and control of our documents. The initial implementation includes integration with our CAD and ERP systems, as well as replacement of our former PDM system."



Customer success: Engineering process management



Gamesa Aeronautica S.A. is engaged in the development of new technologies applied to industry, aeronautics, energy, and services. The Gamesa aeronautical division — based in Vitoria, Spain — manufactures aeronautical structures, as well as parts made from composite materials for leading aircraft companies (such as Embraer and Sikorsky Aircraft Corporation).

Gamesa provides assemblies such as fuselages, empennages, wings, nacelles, main landing gear doors, and interiors for commuter aircraft and helicopters. Numerous design changes have ripple effects throughout the entire aircraft.

"Keeping track of these changes, when each of them could create interferences or other problems, was a nightmare." says Jose Ignacio Uriarte, Gamesa's manager of project management and scheduling.

Gamesa was looking for a complete solution — one that would interface with its CAD and ERP systems, detect design errors upfront, and manage the entire digital product development approach. Gamesa uses Teamcenter Engineering and Teamcenter Visualization as its company standard.

"Gamesa selected Teamcenter Engineering and Teamcenter Visualization because of their superior ability to match function with Gamesa's specifications for configuration and change management, as well as their excellent integration with Gamesa's legacy ERP system and CATIA application," says Uriarte.

"Gamesa was impressed with Teamcenter Engineering's technology, including its state-of-the-art engineering portal, as well as EDS' corporate strategy and direction for the future. Equally important to our decision were the highly competent EDS personnel who supported the Gamesa selection process.

"Teamcenter Engineering helps us manage electronic mockups of each individual aircraft during the development cycle that we use to detect the vast majority of design errors before we begin building the prototype."

Optimizing product engineering

Teamcenter Engineering treats the earliest stages of your product lifecycle as a tangible business asset that you can streamline, manage, monitor, and improve on a rigorous and systematic basis.

Teamcenter Engineering eliminates the geographic boundaries that slow down your engineering processes and prevent you from efficiently delivering engineering information to the manufacturing stages in your product lifecycle.

Don't let the opportunity to optimize your engineering processes pass you by. Contact your EDS sales representative now for more information about Teamcenter Engineering — the world's first multi-CAD engineering process management solution for multi-site product teams.

About EDS

EDS, the leading global services company, provides strategy, implementation and hosting for clients managing the business and technology complexities of the digital economy. EDS brings together the world's best technologies to address critical client business imperatives. It helps clients eliminate boundaries, collaborate in new ways, establish their customers' trust and continuously seek improvement. EDS, with its management consulting subsidiary, A.T. Kearney, serves the world's leading companies and governments in 60 countries. EDS reported revenues of $21.5 billion in 2001. The company's stock is traded on the New York Stock Exchange (NYSE: EDS) and the London Stock Exchange. Learn more at eds.com.

About product lifecycle management solutions

EDS is the market leader in product lifecycle management (PLM), providing solutions to the global 1000. Product lifecycle management enables all the people who participate in a manufacturer's product lifecycle to work in concert to develop, deliver, and support best-in-class products. As the only single-source provider of PLM software and services, EDS can transform the product lifecycle process into true competitive advantage, delivering leadership improvements in product innovation, quality, time to market, and end-customer value.

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