~~UNIT 1~~ : Introduction to product life Cycle management :
- → PLM Life cycle model
- → Threads of PLM
- → Need for PLM
- → Opportunities and benefits of PLM
- → Views of PLM
- → Components of PLM
- → Phases of PLM
- → PLM feasability study
- → PLM Visioning.

1) Definition : " PLM is an integrated information driven approach to all aspects of a product's life, from it's design through manufacture, deployment and maintenance - culminating in the products removal from service & final disposal."

or

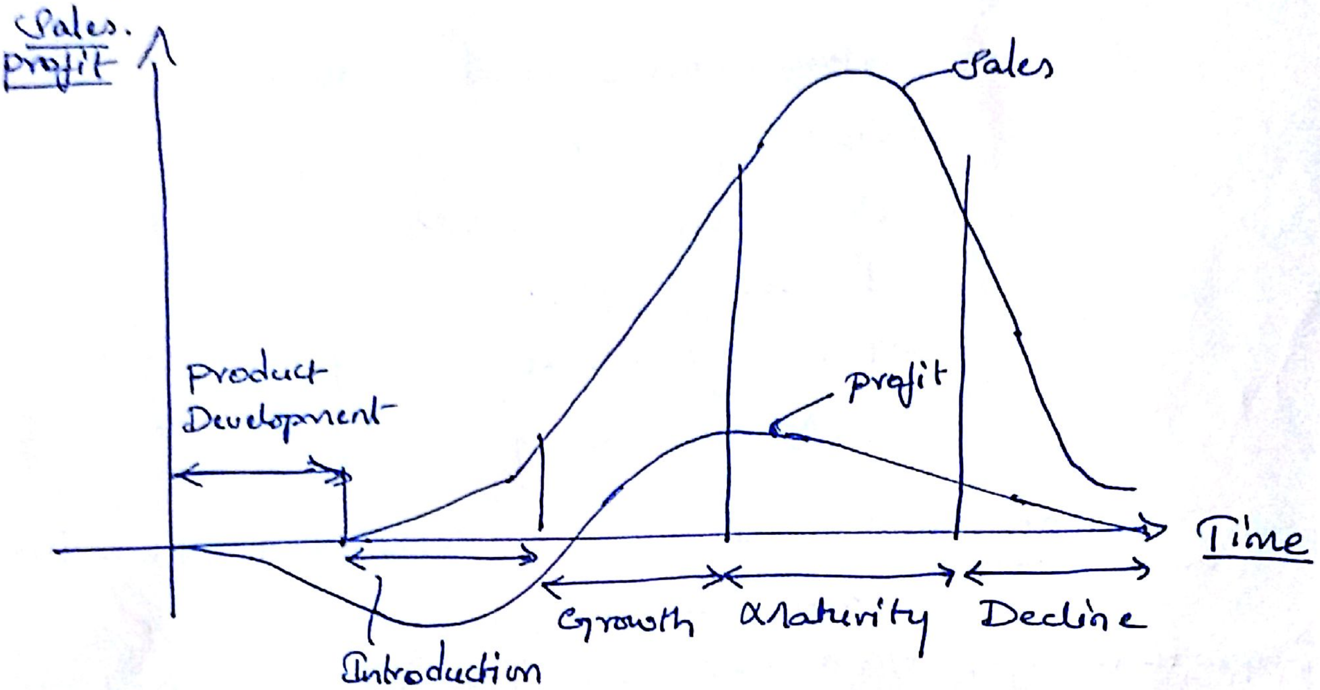
"PLM is the process of managing the entire lifecycle of a product from it's conception, through it's design and manufacture, to service and disposal. PLM integrates people, data, processes and business systems and provides a product information backbone for companies and their extended enterprise."

2) ~~Threads of PLM~~ ~~Product life cycle~~ model

PLM helps in betterment of
1) Customer Relationship management [CRM]
2) Supply chain Management [SCM]
3) Enterprise resource management [ERM]
4) System development Lifecycle [SDL]

③ Product life Cycle model / PLM life Cycle model

Product life Cycle model can be defined as " the change in sales volume of a specific product offered by an organization, over the expected life of the product".



product life cycle graph for a product

→ The product life cycle describes the sales pattern of a product over time.

→ All the products pass through the ~~sales~~ stages outlined below.

→ There are five stages in the product life Cycle model and the brief description of them is given in following sections.

Ⓐ product Development stage

→ In product development stage the requirements of customers are acessed and plan for the product is made.

→ The functions which product must perform and the requirements the product must meet are specified.

-> The requirements specified are taken up for concept engineering and prototyping, and the concerned people make sure that their concepts and prototypes meet all the mandatory functional requirements desired.

-> Money is invested by the company in this stage and is shown by -ve profit on the curve.

ⓑ. Introduction - stage

-> The product is new to the market and few potential customers are aware with the existance of product.

-> promotion is extensive and main objective is to Capture maximum possible market.

-> Product is put into limited outlets or channels and product sales takes up slowly.

-> The patents and trademarks for product can be obtained.

-> price is generally high and promotion is informative and personalised.

ⓒ Growth - stage

-> product start becoming more widely known and acceptable in market.

-> Marketing is done to strengthen the brand and develop an image for the product.

-> Sales takes off and ~~product~~ profit begins to come.

-> The price begins to decline with the entry of new players.

ⓓ Maturity-stage

-> The product is competing with alternatives and sales and profits are at their peak.

-> The price may reach its lowest point due to increased number of competitors.

-> Advertizement is done to reinforce the product image and to increase the repeat purchase

-> The new features can be added to the product at this stage.

(e) Decline - stage

-> The product popularity is decreasing and people starts moving towards new products.

-> The promotion (or) advertising focused on reminding.

-> The sales volume reduces and price will fall.

-> The product faces reduced competition as many play-yers have left the market and it is expected that new competitor will enter the market.

3] Threads of PLM

PLM took existing threads of concepts and technologies that existed in their own right and wove them together to form this new concept [PLM].

Taking a close look at PLM, one can discern some of the conceptual and technological threads that have gone into forming PLM.

These threads are

(a) Computer aided design [CAD]
(b) Engineering data management [EDM]
(c) Product data management [PDM]
(d) Computer integrated manufacturing [CIM].

(a) Computer Aided Design [CAD].

-> CAD refers to math based description of physical representation of products.

-> CAD uses system of Mathematical description to locate and considerably replicate the shape which are 2-D and 3-D space.

→ CAD system are started to air designers in producing faster and more accurate drawings. and also to replicate the designs whenever necessary, hence the name computer aided design.

(b) Engineering data management [EDM]

→ The math-based CAD information needs to be augmented by other information, called characteristics.

→ characteristics can be described as any information that is needed to describe the product & include Tolerances, tensile strength, weight restrictions etc.

→ Information such as - the process for building the product, the methodology for coating or painting the product, and methodology for testing the product - needed to be associated and managed with the product is the focus of EDM.

→ The program used predominantly for EDM data collection, tracking and reporting is Microsoft's Excel Spreadsheet.

→ EDM consists of data and information that ~~abstracts~~ abstracts, defines & describe the product.

(c) Product data management

→ PDM is developed to organise CAD and EDM information in databases that were prestructured.

→ The primary purpose of PDM was to replace an organisation's reliance on paper/microfiche archives with a reliance on electronic archives.

→ PDM introduced that the product data could safely and effectively be organized, maintained, and accessed in digital form.

-> The focus of PDM is to manage the product data in the design and engineering functions.

(d) Computer integrated manufacturing [CIM]

-> In CIM, the product development and manufacturing activities with all the functions being carried out with the help of dedicated software packages.

-> CIM embodies the idea that a computer system could integrate the functions necessary to design, engineer and manufacture a product.

-> In CIM, the data required for various functions are passed from the application software to other in a seamless manner.

ex: Transferring data from modelling software to manufacturing software.

-> CIM uses common database wherever feasible and can reduce duplication of efforts and wastes and results in increased productivity which is a major aspect of PLM.

4] Need for PLM

(a) Outsourcing: As the outsourcing leads to long design and supply chains and product development, and support activities are spread ~~over~~ out over different organisations at different locations, the collections of information and managing these activities becomes difficult. Hence PLM is needed to cater for all these necessities.

(b) Functionality: As the functionality of a product increases the complexity in product development and support [service (or) Maintenance] increases. PLM data provides information necessary to make easy development and service to the product.

(c) To appropriate supply chain management

~~(d) To prioritize~~

(d) New technologies : The emergence of new technologies in different areas of product life cycle has led to many opportunities - but also the difficulties of industrialization of these technologies and ensuring their safe use in one of the challenges faced by organisations. PLM helps to solve these problems by selecting most appropriate technologies.

(e) Population Trend : population trends, such as ageing in western countries lead to the need for new types of products. PLM studies the requirements of the people and facilitate to develop required products.

(f) Sustainable development : Environmental responsibility and sustainable development is needed to ensure resources are available for future generations. PLM gives best possible resource allocation and avoiding the wastes.

(g) Future planning : (a) Next generation planning
The lifetime of some products now is so short, that the development of a future generation has to start before the development of the previous generation has been finished. PLM facilitates visioning for next generation

(h) Competitive pressures : Competitive pressure results in less time available for development of new products. (b) Re-designing existing product. PLM data consists of results from all stages of product life and ~~for~~ intimates abouts best time for reinventing or going for new product.

5) Opportunities and Benefits of PLM

Opportunities

There are huge opportunities for PLM in manufacturing companies. Some of them are as follows.

-> Globalisation has increased the number of potential customers for their products and services and has increased the need for PLM ~~than~~ than ever.

-> Electronics, BT and NT [Biotechnology and Nano-technology] provide the basis for new products, and PLM is nothing but the window for developing and supporting new products.

-> Development of Computing, Internet, smartphones and database technology will create and meet needs that had not even been thought of before.

-> RFID [Radio frequency identification] offers numerous Opportunities to get a better understanding and tracking the way products behave over their lifecycle.

-> ~~Environmental~~ Environmental requirements and the desire for sustainable development will open up new opportunities for new products and services.

Benefits

PLM can help a company to improve effectiveness, efficiency and control throughout the entire product lifecycle.

The benefits of PLM can be categorized into three sections

(a) General benefits
(b) Based on Revenues
(c) Based on cutting cost.

(a) General benefits.
-> Captures customer Requirements better
-> Reduced time to market
-> Improved product quality and Reliability
-> Reduced prototyping costs.
-> Reduced waste [Time, material, Energy]
-> Improved process stability
-> provides outsource manufacture to low cost and optimal quality suppliers.
-> deliver required product at the required time and place
-> Facilitating product development in an International Collaborative development environment.
-> Provide better product maintenance and service until the product is eventually recycled and disposed off in an environmentally-sensitive manner.

(b) Based on increasing revenues
-> Increasing number of customers by developing and supporting new products.
-> Increasing product prices by increasing product quality, also by including new features and functions. Being first to market enables pricing premiums.
-> providing customer specific variants of products.
-> Increasing the service price paid by the customer by providing quality service.

(c) Based on cutting costs
-> Reduces material and energy consumption costs by use of optimised design, better decisions, more reuse and better purchasing.
-> Reduces direct labor costs across the life cycle by avoiding delays in procuring product data by the workers.
-> Reduce overhead labor cost by using PLM ~~for~~ to avoid documentation shuffling and data re-entry.
-> Reducing cost of quality using PLM to eliminate errors made in marketing, engineering, manufacturing, delivery, service chain

6] Views of PLM

Different users will want to see different views of product data.

-> A manager may want to see current progress on all parts of a product development project, but not details of the design itself.

-> A project engineer may want to check an assembly of parts, but have no interest in stress (or) Thermodynamic analysis results.

-> A drafter may only be interested in an individual part.

-> A company may want to give a supplier a very restricted view of it's overall database.

In all the above cases, while users may want to see different views of the data, and the systems they use may be different, the underlying data must be the same.

7] Components of PLM

(a) product data and product

-> product is primary component of PLM, because without product the company do not exists.

-> The product data consists of information related to both product and process that are used to define, produce use and support it.

-> product data involves project plans, geometric specifications computer programs, experimental investigation results etc

-> PLM organises the product data in proper format to provide easy accessibility.

(b) Customers

-> customers are the gods of any organisation. The success of a company purely depends on customers.

-> If the company fail to develop customer loyality and to satisfy the customer then the organisation could lose the customers.

-> PLM softwares are used to have a customer review/feed back of a product to avoid the failure in customer relationship.

-> Customer feedback allows companies to know how customers rate and use their products over the competitive products.

-> Implementation of PLM leads to know in what area the products need to be improved.

(c) product life cycle activities

-> Once the idea about new product appears, the product portfolio has to be built up.

-> The product life cycle involves many stages such as plan, build, design, service and recycle.

-> PLM provides better visibility and control over the product life cycle activities when they are carried out.

(d) Organisational structure

-> Organisational structure is defined to make all the activities manageable.

-> In todays situation creating the organisational structure is one of the challenging task.

-> But implementation of PLM has proven that, it provides an approach to organize and integrate the different functional areas of an organisation to achieve the goals of the organisation.

-> Using PLM groups, teams, services & departments may be created in a company to carry out all sorts of activities such as

* product design * Manufacturing * purchasing
* Logistics * Sales & Marketing etc.

(e) Human Resource in product life cycle

-> Human resource play an important role in any company whether it is full, semi or non-automated.

-> Many people outside the company such as sales representatives and within the company such as engineers are involved in different stage of product life cycle. [Accountants, IT mangers, Engineers, Accountants, Service engineers, HR administrators, project managers.]

(f) Methods, techniques, practices, methodologies

-> Various techniques have been proposed to carry out product development and support more effectively.

-> All these techniques should be understood by companies embarking PLM.

-> One of the challanges of PLM for a particular company is to identify the techniques that are most relevant to the activities on which the company wants to focus it's efforts.

ex: * Bench marking, Business process Re-engineering, Concurrent engineering, configuration management, Allaiance management, PDCA cycle, Failure mode effects and criticality analysis, Fault tree analysis, Cause and effet diagram. etc

(5) System components of Life cycle

→ "Just as many techniques are available to improve the traditional work flow (product work flow) many application systems are also available.

→ One of the challanges of PLM for a particular Company is to identify the techniques that are most relevant to the activities on which the company wants to focus it's effort.

ex: CAD, computer aided Engineering CAE, Computer aided manufacturing (CIM), Rapid prototyping (RP), Simulation, ~~Computational fluid~~ Computer aided manufacturing (CAM). etc.

(4) Processes

In each phase of the lifecycle there are processes which may be specific to a product (or) project or to an organisation.

They could include

* Design, Document Control, Disposal, manufacture, packaging, modeling, production, prototyping, quality Control, Leadership, Handling, inspection etc.

8] phases of PLM

Phase 1: Conceive [Imagine, Specify, plan, Innovate]

→ The first stage of product is the definition of a product's requirements based on customer, company, market and regulatory bodies viewpoints.

→ From above information the specifications of the product's ~~life Cycle~~ major technical parameters can be defined.

-> Initial concept design work is carried out defining the visual aesthetics of the product together with its main functional aspects.

-> For the industrial design, styling many different media are used from pencil and paper, clay models to 3D - Computer aided Industrial design softwares.

Phase 2 - Design [Describe, Define, Develop, Test, Analyse, and validate]

-> Detailed design and development of the product from the start, progressing to prototype testing, through pilot release to full product launch are involved in this phase.

-> It also involves redesign and ramp for improvement to existing products as well as planned obsolescence.

-> The tool used for design and development is CAD. which include 2D & 3D modeling, Feature based solid (or) surface modeling

-> This phase covers many engineering disciplines including, Mechanical, Electrical, Electronic, software and domain specific such as architectural, Aerospace, Automotive etc.

-> Along with actual creation of geometry there is the analysis of the components and products. assemblies.

-> Simulation, ~~and~~ Validation and Optimisation tasks are carried out using CAE (computer aided ~~design~~ engineering) software either integrated in CAD package (or) stand alone.

-> The CAE softwares are used to perform stress analysis, Finite element analysis, Kinematics, Computational fluid dynamics, computer aided quality etc.

-> Sourcing of bought out components is also done at this stage with the aid of procurement systems.

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Phase - 3 : Realize [Manufacture, Build, Make, produce, Sell, and Deliver].

-> Method of manufacture is defined in this process. (or) phase.

-> Involves tool design and creation of CNC machining instructions for the parts and softwares required for CAM.

-> This phase also involves analysis tools for process simulation for operations such as casting, molding, and die press forming.

-> Now computer aided production planning is used carry out factory, plant and facility layout and production simulation.

-> Once the components are manufactured their geometrical form and size can be checked against the original CAD data with the aid of computer aided inspection equipment and software.

-> Along with manufacturing tasks, sales product configuration and marketing documentation work will be carried out. It includes transferring engineering data to a web based sales configuration and other publishing system.

Phase - 4 : Service [Use, operate, Maintain, Support, sustain, Phase-out, Retire, Recycle and Disposal].

-> The final phase of the product life cycle involves managing in service information.

-> providing customers and service engineers with support information for repair and maintenance as well as waste management / recycling information.

-> This phase involves using tools such as Maintenance, Repair and Operations management [MRO] software.

(9) PLM feasibility study

The PLM feasibility study is carried out in order to find out what type of approach and what is the level of response that the company faces during the introduction of new product into the market.

The feasibility study can be briefed as follows.

→ may be an enterprise-wide initiative targeting new product which are market leading and control over the entire lifecycle is needed, in which case it would be useful to develop a PLM vision, a PLM strategy and a PLM plan.

→ may be main benifits can be acheived by implementing new lifecycle processes across several functions and PLM helps in deciding which new technology (or) processes that should be implemented in every stage of product life cycle.

→ may be there are benefits to be had by targeting some very precisely defined improvement areas.

→ Any initiative will lead us to several options and for each option the question to be answered are what? How? why? Who? when? where? How much?.

10 PLM visioning

→ A PLM vision is a high-level conceptual description of a company's product life cycle activities at some future time.

→ PLM visioning outlines the best possible forecast of desired future activities related to the product development.

→ PLM visioning helps the managers in organisation to select the proper choices that they have to make during

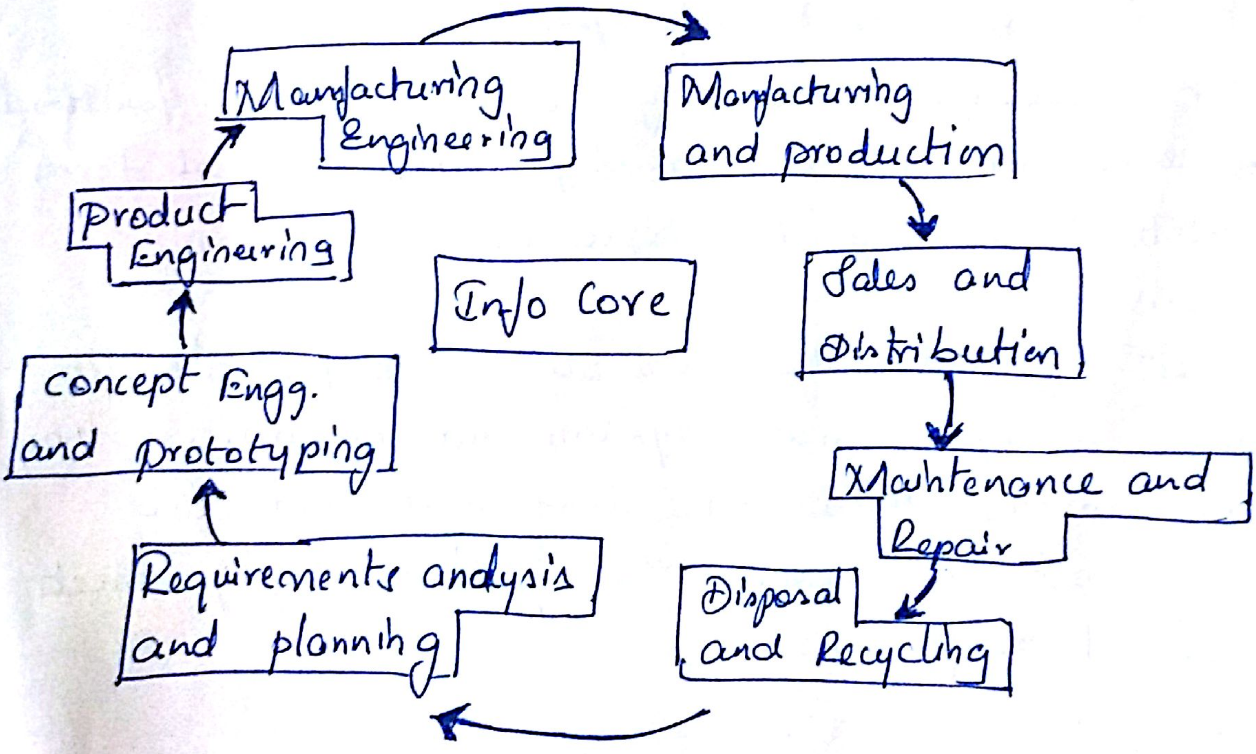
* Strategy setting
* planning
* prioritizing
* capabilities
* Budget.

→ A PLM vision will be company specific

→ Because of difficulty in looking further into the future than a few years, it is appropriate to develop a vision for PLM for five years in the future.

→ A PLM vision is built on the assumption that the company wants to carry out it's product lifecycle activities as effectively as possible.

11) Product life cycle model



PLM model (or) Product life Cycle model

At the center of the PLM model is the information core and this core represents all the product data and information about the product through out the product life. Around the information core it comprises of stages of product life cycle which are generally categorised as plan, design, build, support and Dispose.

Plan :

-> The model starts with requirement analysis and planning. One must plan/assess what are the ~~product~~ functions that the product must perform ?, what are the requirements the product must meet?. etc

-> The requirements are mapped into specifications and set of plans are prepared which are taken up by Concept engineering and prototyping.

-> After succesful prototyping i.e if all the functional requirements are met by prototype, the general form of prototype is completely specified by product engineers

-> product engineers make sure various components fit together in an integrated system, and in addition they perform various tests on components and the entire product to ensure that the product really meets the required specifications.

Build :

-> The fully specified product is taken up by manufac-turing department to determine how the product will be built.

-> The designs must be analysed to specify what operations must be performed and in what sequence to create the desired components or product.

-> The produced components ~~then~~ must then be assembled in a specific sequence to realize the completed product.

-> This category involves 3 distinct phases

* Building the first product
* Ramping up production
* Building the rest of the components.

Support

-> The marketing function uses the product information to tell the buyer/user about the product and its functions and specifications

-> The service (or) maintenance department strives to keep the product ~~product~~ performing at specified or desired condition using the product information.

Dispose

-> The final aspects of product life cycle is disposal and recycling of the product.

-> The information of how products were designed and manufactured plays vital role in easy, safe and efficient disposal and recycling of used product.

-> The cycle starts all over again with the next version of existing product (or) a new product.

PRODUCT LIFE CYCLE MANAGEMENT

UNIT- 2 : PLM Concepts, processes, and workflow.

-> characteristics of PLM
-> Environment driving PLM
-> PLM elements
-> Drivers of PLM
-> Conceptualization
-> Design
-> Development
-> Validation
-> production
-> Support of PLM.

I characteristics of PLM

There are certain underlying characteristics that are an integral part of PLM. These characteristics need to be articulated for a robust understanding of the forces which drives an organisation to adopt PLM. These characteristics include

a) Singularity
b) Correspondance
c) Cohesion
d) Traceability
e) Reflectivity
f) Cued availability

a) Singularity

-> Singularity within PLM is described as having one unique and controlling version of product data. Unique means exclusive and controlling means the one which all agree.

-> Lack of information singularity is major source of wasted time, energy and material.

-> The ability to manage singularity of product data must be the primary characteristics of the PLM Softwares

-> More complex and voluminous the design and plans are, it ~~is~~ more difficult ~~to duplicate the~~ it is to duplicate them. But the computer technology has added to lack of ~~sig.~~ singularity as now large and complex data can be duplicated at minimal cost and effort.

b) <u>Correspondence</u>

-> Correspondence refers to the tight linkage between a physical object (eg. a component, part or product) and the data ~~and~~ or information about the physical Object.

-> The data regarding geometrical shape, and dimensions and characteristics such as material, weight, Color, tensile strength etc is emboided into physical objects and we extract this data using tools and methodologies. Or these data are specified while designing and then the product is manufactured.

-> In both of the above cases a core characteristic of PLM is to develop and maintain a correspondence between the physical object and Information about this Object.

-> If we donot maintain seperate information of product we must spend time, energy and material to get it.

<u>Example</u>: If we want to find a particular model of ~~fuel~~ + oil pump fitted to a machine or not - one method is to disassemble the machine and check it (or) the other is ~~by~~ maintaining the machine assembly checklist.

c) Cohesion

→ Cohesion refers to fact that the information can be represented in a different ways depending on the perspective of product.

→ Since cohesion is related to product information it's been found that, if there is no proper cohesion then ~~there is may~~ it may prove non profitable to any organisation.

→ A common ~~expan~~ example may be lack of cohesiveness in Bill of materials [B.OM] of product in different functional areas of an organisation.

→ If engineering unit has one B.OM., manufacturing unit has one BOM and finally financial department has BOM that neither matches with the BOM of Engineering nor manufacturing unit.

→ As a result inconsistant BOM from different units leads to make non-profitable decisions that leads to loss.

→ One of the approach to obtain cohesiveness is to reduce the number of independent views and to derive the abstracted view from individual teams and prepare the proper B.O.M that focus on goals of an organisation.

d) Traceability

→ Traceability is the ability to demonstrate ~~that~~ the path of products travel through time that follows seamlessly to it's origin.

→ The ~~trace~~ traceability refers to creation of documentation or physical evidence on paper. The documents i.e Design's, notes, drawings that are related to respected product version are collected and arranged in a proper

Chronological order so that ~~if~~ even if there are any mis-calculation are there during the product design one can path/trace back to it's origin.

→ One cannot decide which is succesful version and unsuccessful version effort of product. If One chooses the unsuccessful version to build the product and eventually realize after the waste of time, energy and material it is very difficult to compensate those intangible losses.

→ To ~~ab~~ avoid the situation like above traceability Could be implemented.

→ In Traceability one can have the ability to Capture Information at it's ~~core~~ source, Also, traceability will provide the ability to find and enhance the product development process.

Therefore PLM should have traceability characteris-tic as it's core element.

e) Reflectiveness

-> Reflectiveness captures the data from real space into the virtual space.

-> In real space any modification will be visible in physical object.

→ We need a system to change the information in virtual space to the corresponding information changes in the real space.

→ The purpose of reflectiveness is to allow us to substitute the correct information for wasted time, energy and material.

-> To examine and extract the information from virtual space is less expensive.

→ Reflectiveness also helps us to track built products to check if a specific component has been used in a specific product.

Example : i) In an example of accessing inventory record that contains quantity and allocation of specific items about which we want to know or directly visiting the inventory/warehouse

ii) In indian railways the in-charge authority easily get to know the exact location of the train by having virtual environment.

v) Cued Availability

→ Cued availability is related to the arrow indicating the movement of information and process from virtual space to the real space.

→ Cued availability is simply being able to have right information and processes whenever needed.

→ The term cued indicates that one might (or) might not be searching for a particular information and process. But because of the situation one may be presented with them.

→ Without the cued availability the information mirroring model is simply a vault, where it would collect the changes that took place in physical/Real space.

→ For example with the use of cued availability, when a product goes into recycling one will be provided with appropriate product information and process and thus reduces the time required to collect the information about the existing product.

② Environment driving PLM

Note: Bill of materials or product structure is a list of the raw materials, subassemblies, intermediate assemblies, sub components, parts and the quantities of each needed to manufacture an end product.

BOM may be used for communication b/w manufacturing partners, or confined to a single manufacturing plant.

There are many factors that drive the need for PLM in any organisation. The previous techniques and technologies ~~so~~ are not sufficient in today's competitive market. The changes appear incremental when looked day by day, the difference are truly dramatic when viewed over a longer time frame. The fundamental requirements emerging from within the business environment that are driving PLM include a need to improve productivity, the rate of innovation, collaboration and quality.

The ultimate driver of PLM and the Organisation's decision to invest in PLM solutions will be their ability to create value for the Organisation.

The drivers for PLM include External and Internal drivers.

External drivers

The external drivers are out of control of an

organisation's management. They include
a) Scale
b) Complexity
c) Cycle times
d) Globalisation
e) Regulation.

a) Scale or Scaling

-> In order to appreciate the status/scale of any organisation in the present situation it's needed to go back and look to an extended time period to see what are the changes that have been taken place in an organization over a period of time.

-> Generally, the most common problem faced by one is that the difficulty in observing the changes that are taking place in the environment within which they are living with.

-> It's possible to focus on these changes only whenever there is a longer view on these magnitude of changes.

-> Also in any event it is clear that the scale of companies will be dramatically increase over a period of time.

-> As the scale of these companies goes on increasing it becomes difficult to manage the data b/w different functional units, and at situations like this PLM becomes a requirement.

→ With the implementation of PLM the information system that drives the company will be well managed and one can avoid wastage of time, energy, money and human resources in managing the product's information.

→ Thus PLM becomes the integral part of these large scale organisations.

Example: The following table illustrates the growth of a few US gaints.

	Company	1973	2003	Growth
1)	General motors	$35 billion	$186 billion	5.3 times
2)	Ford	$23 billion	$164 billion	7.1 times
3)	General Electric	$12 billion	$134 billion	11.1 times
4)	Wal-mart	$126 billion	$255 billion	2.031 times.

It is hard to come up with a reason other than use of information systems that would have allowed these companies to grow in such magnitude in such a short period of time.

b) Complexity

→ Today not only organisations are getting bigger, but they are producing more and more complex products.

→ The result of complexity is the dramatic increase of amount of data and information that needs to be created, cataloged, and monitored. We not only have to deal with a sheer increase in the number of different product models, but with an increase in the complexity of product themselves.

→ When we add the additional requirement [illegible]
for tracking this data and information throughout the product's life, the size of the task becomes clear and easy to manage.

c) <u>Cycle times</u>

→ The cycle times refers to the time required for a product right from it's conception till it's final product stage.

→ Today not only the scale of organisation and the complexity of products getting larger but the timeframe that they keep for completion of product is shrinking dramatically.

→ The reason for shrinking cycle times may be the organisations are being forced by their competitors and their customers to create products on a much faster cycle time than they have in past.

Ex: In past years automotive industries used to have a design cycles of 7 years from conception to production, but today the design cycle is 0-3 years.

→ The decrease in cycle times has a dual impact, first they substantially increase the amount of information that needs to be collected, processed, accessed and stored in shorter time frame.

→ Secondly the decrease in cycle time refers to elimination of the functional areas/processes that uses inconsistant information in the organisation.

→ Implementation of PLM will help the organisation remain synchronized with the system and one can identify the inconsistant information that has to be reconciled and reworked to reduce cycle time.

d) Globalisation:

→ Companies now have the possibility to sell their products and services worldwide due to Globalisation. They have the opportunity to find many new customers and increased sales.

→ On the other hand globalisation has increased the number of competitors worldwide which insists the companies to develop better products, at faster rates and at lower cost.

→ Globalisation also implies ~~they~~ Organisations have to be close to customers in many places, and understand customer requirements and sell products in many environments. They also have to provide technical information, parts, products and service in many location - and meet regulations in many countries.

→ The days when the product information resided in a single, physical area and everyone who needed to have access to it could walk over to a file cabinet or drawing vault and access it are long gone. Today companies have R&D, design and manufacturing centres spread ~~across~~ out not only across the nation, but across the globe.

→ This means PLM will need to be the repository to all information so that no matter where the individual is on the globe, he or she will be able to access and use that information - and more importantly, update it so that counterparts in rest of the world can to have access to it.

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e) Regulation

→ All external drivers explained before are different compared to Regulation. Because an organisation can choose whether or not to respond to them. The managements of an organisations can make assessment as to the impact of those drivers and their response to them.

→ But Government regulations are not in above category. Government regulations are certain set of standards and rules that an organisation must comply or face immediate and severe consequences.

→ Governments have increased their regulatory power in areas of safety, external costs [pollution, hazardous and toxic material use, disposal and landfill concerns], and asymetry in the balance of power between manufacturers and customers.

→ The increase in governmental regulations has forced organisations dramatically to revise their perspective of the scope of relevant product information involving whole product life cycle.

Ex: In case of automotive vehicles the developers has to be concerned not only about it's design and development but also on recycling and disposal rate of the individual parts after their service life so as to meet the standard / requirements of the environmental directives set by the government.

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Internal drivers

Internal drivers, are those drivers within the Organisation that acts under the influence of management of the organisation. These internal drivers are the critical areas that the organisation should focus upon if they want to overcome the challenges of the external drivers.

Some of the internal drivers are

a) productivity
b) Innovation
c) collaboration
d) quality.

a) productivity

-> productivity refers to the ratio of output that an organisation obtains over the specific amount of inputs or resources it takes to produce that output.

For tangible products the outputs may be, Automobiles, aircraft, smartphones, Buildings etc.

The inputs are Human resource, Raw materials, Technology etc.

-> The output is measured in terms of units or parts.

The productivity is mathematically represented as

$$\text{productivity} = \frac{\text{No. of units produced}}{[(\text{Time} \times \text{wages}) + \text{Energy} + \text{material} + \text{Information cost}]}$$

-> All organisations try to improve their usage of resources per unit of output. They have to increase their productivity in order to decrease their costs in line with decreasing prices

-> Many organisations have embraced six sigma and lean manufacturing in order to adress the productivity issue.

→ ~~Many organisat~~ Outsourcing is another attempt to increase productivity.

Note: Outsourcing provide the opportunity for a company to focus it's effort on the activities it considers most important and/or provide it's competitive advantage, while getting other companies to carry out activities it considers less important.

→ ~~A company which outsources~~ The companies an organisation outsources to can usually do the outsourced activities better or at low cost.

→ But outsourcing or any productivity increasing techniq-ues mentioned before modifies a ~~f~~ company's flow of information and materials - leading to the need to realign process and systems.

→ Hence PLM can be implemented to obtain better control over the information in the product life cycle.

→ PLM also enables an organisation to move around the globe in search of lower wage rates for outsourcing or to build a new plant and PLM also facilitates to increase productivity by identifying most efficient processes to reduce the time, energy and material costs.

b) Innovation

→ There are two distict elements of innovation within most organisations. The first is product innovation and the second is process innovation.

→ productivity is concerned about the cost reduction and Innovation is concerned about increasing revenues.

→ product innovation gets more and more attention, b because the results of product innovation are the lifeblood of an organisation.

→ The second element process innovation is generally a behind the scenes activity.

→ Companies that fail to continue to innovate are overtaken by competitors who introduce new and innovative products into the market. The innovation of the product function is the goal of many organisations.

→ With cycle times decreasing, the pressure on organisations is increasing to become more innovative in their product development. [The one who has faster cycle times and gets his innovative products to the market quicker well capture the market immediately].

→ Cosmetic changes can constitute new versions of the product but relying on cosmetic changes only is risky, hence the far better solution is to innovate.

→ While innovation requires more than collecting, organizing and coordinating product information from all phases of product life cycle, PLM is an important enabler for succesful product innovation. One way that PLM contributes to innovation is by freeing up resources that might otherwise be wasted.

→ On the other hand the goal of process innovation is to find better technologies and methods in order to reduce the time, energy and material that are required to produce the product.

c) Collaboration

→ Today the meaning of collaboration has changed from working together at same time and in same place to working together over space and over time.

→ when we start distributing work across the globe, we need to concern ourselves with this new type of collaboration. The farther we seperate people in space and time, the collaboration becomes difficult.

→ The increase in scale of our organizations and the move to globalization have disrupted our natural ability to collaborate.

→ The premise that is behind the move to PLM with respect to collaboration is that if we cannot co-locate in physical space and time, then we should attempt to co-locate in our virtual space and time.

→ PLM attempts to re-create in virtual space the richness of communication that collaboration requires.

d) Quality

→ The lack of quality is another way of describing wasted time, energy and material. There are two aspects to quality. First, quality is the characteristic of the product meeting it's specifications. The second aspect of quality is performing to a particular standard of usage.

→ The first aspect is controllable but the second is often not.

→ A good reason to focus on quality is simple economics. products that meet their specifications do not need to be scrapped, reworked or repaired.

→ One of the main causes for quality issues is lack of Information as to what specifications the product should be manufactured

→ PLM with it's consistant and singular view of the product and it's components enables all the stakeholders to know and understand the specifications.

→ In addition, PLM's ability to convey the specifications visually takes the ambiguity out of product specifications.

→ The second aspect of quality, and probably the more important of the two - the ability of a product to meet a certain standard of usage - is much less controllable and more problematic.

→ It is difficult to perfectly map requirements to specifications. PLM can assist by using it's different virtual spaces to test a wide range of product ~~stas~~ states and conditions in substantially less time and at a lower cost.

Boardroom driver - IT value map

→ The external and internal drivers of PLM explained above are interesting but there must be some means to translate them into economic terms in order for organizations to evaluate and acte upon them.

→ Since PLM impacts on many different functions, the decision to invest in PLM logically is made at the upper levels of the organisations on the basis of the quantified value it brings to the organisation.

→ Although the drivers mentioned previously are moving organisations, but, in the end analysis, if the value PLM brings cannot be ~~quah~~ quantified and explained to the executives and board members who approve capital expenditures, it will not be adopted

~~→ Although there are qualit qualitative values~~

→ Althought there are qualitative measurements of value, such as the reputation of an organisation, the quality of work life for it's workers, and it's standing in the community, the decision to invest in PLM solely depends on financial analysis.

→ <u>Return on investment [ROI]</u>, ~~which~~ the increase in income of an organisation as a result of an initiative, divided by the amount of resources that the organisation needs to invest in that initiative is the measure commonly used.

→ ROI often includes the allocation of resources, such as personnel, space, overhead etc that already exist within the organisation. The effect is that there is no real investment being made.

→ For the above reason a new measure <u>Return on Assets [ROA]</u>, which is the change in income divided by the cost of the asset, is used as our comparison benchmark.

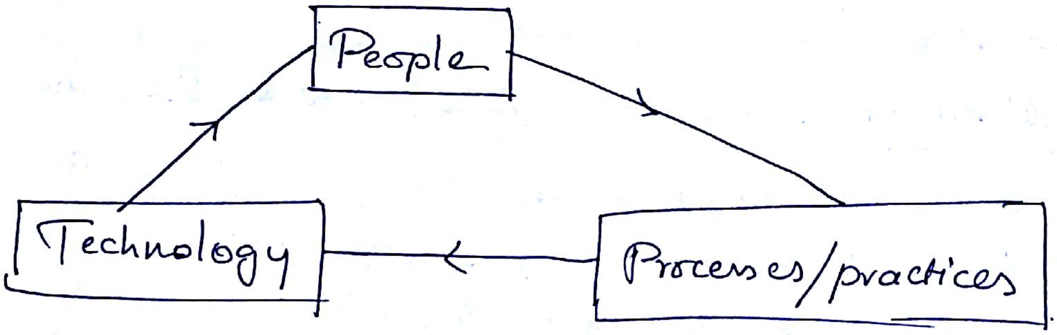
→ Adding an asset requires expending cash, which is carefully watched even in the biggest, most successful Organisations. Expenditure of cash requires approval of the senior executives and/or board of directors, whereas re-allocating existing resources does not. ~~(uso~~ (usually).

→ The approval group will look forward for an impact in income in order to justify adding the asset to balance sheet.

→ Hence ROA is used as a more stringent measurement ~~to measurement~~ to measure effectiveness of an initiative compared to ROI.

3) Elements of PLM

Elements of PLM are represented using People, processes and Technology triangle. as shown below.



People are at the top of the triangle indicating their dominating role. However, all the three elements must perform in their own right and work together cohesively to make for an effective implementation of PLM.

~~Implementing~~ PLM focuses not only on product information but also on people, processes/practices and technology available in the organisation.

a) People

Individuals within an organisation come equipped with a wide range of capabilities. The important and relevant characteristics of people are

i) Experience ii) Education and training iii) support iv) change capacity.

i) Experience : Experience is accumulating information and knowledge about different situations in order to be able to trade off information for wasted time, energy and material. Experience is an individual characteristic. If an experienced individual leaves, so does the experience. Organisations no longer have the luxury of the time and cost of waiting around for people to gain experience. Increasing product complexity and decreasing cycle times mean that we need to gain more experience in less time.

ii) Education and Training : Educating and Training the people of an organisation will help them to gain experience faster. With training people are taught what to do and how, and with education people are taught why they do it. Training is better suited to processes and education for practices. Information collected within PLM can greatly enhance the effectiveness of education and training. Using information mirroring model, we can develop proactive and structured simulations that will have the same effect as experience for the individual at substantially less expence.

iii) Support : Support is an extension of ~~educt~~ education and training, but takes place during execution of task. The proper support can reduce the inefficiency of the searching and relearning process by providing people with the information they need when they need it.

Required information can be obtained using computer applications supporting PLM. These applications can be used to provide rich communications between individuals.

iv) change capacity : One of the issue with respect to people is the determinant of change capacity. PLM requires a substantial amount of change by people within the organisation. The capacity for change is the determining factor in the success (or) failure of PLM. The willingness of people to change is based on three major factors

* Their belief systems
* Their reward and punishment system
* Their available options.

The best way to get people to perform is to make what we are asking them to do consistant with their belief system.

Coming to reward and punishment system. The rewards system should be crafted so that people would encourage behaviours that are consistent with new activities of PLM. Similarly punishment systems are ~~often~~ often effective at preventing unwanted behaviour.

The last factor affecting change are the options people have. One of the strongest option is always no change. Hence there must not be a choice between using old way of doing things and the new way.

⑥ <u>process/practice</u>

It is important to distinguish between process and practice before going furthur. It is also important that processes and practices can both co-exist within the same procedure or task. For example

→ The process for a design change on a complex product may consists of specific steps that must occur each and every time & specific sign offs that must occur at certain specified points.

→ However, deciding whether the change is consistent with professional and organisation standards in order to be approved or ~~set~~ sent back to for revisions is more likely a practice.

<u>Focus on process</u>

→ process is a very legitimate issue for PLM to focus on.

→ The more we can define processes, the more we can work towars increasing efficiency in a systematic fasion.

→ Because it is much more difficult to define and measure practices, we should be analysing our procedures and tasks and attempting to define & seperate our processes from practices wherever possible.

Focus of practice

→ Unlike processes, practices are judgemental activities.

→ practices uses both deductive & inductive reasoning.

→ practices require the participants to discern the patterns in a pool of seemingly unrelated data and information.

The information requirements are different for practices than those of processes.

→ with the processes the focus is on the movement from state to state as quickly as possible.

→ with practices the focus is on collecting data and information to improve the recognitions of patterns in the future.

The main goal of PLM is to provide the pool of data and information and assist in discerning the correct patterns. With the advent of ~~IT~~ Information Technology (IT) it is now possible to create standards and guidelines that can support practices. In addition practices require rich interpersonal communication and co-ordination.

c) Technology

~~PLM is heavily dependent on the technology application in product development area~~ and

PLM is heavily dependent on the IT applications that solution providers develop in this area. These

~~Thes~~ IT applications in support of PLM must be regularly updated. Since there is a wide ~~voraity~~ Variety of applications targeted at different aspects of PLM and different industry uses, organisations that are in the process of selecting PLM appli--cations need to assess the functions that they require against the functionality of the products in the market place.

There are some issues and observations regarding technology that are independent of any particular application and would be relevant to any PLM implementation. These issues pertain to the environ--ment that PLM operates in, or considerations that any PLM application must take ~~to~~ into account.

- → PLM needs an adequate technology infrastructure
- → PLM applications should be open and harmonise with other applications.
- → PLM applications must be configurable and not customisable.
- → PLM applications must be usable and embedded.
- → PLM applications must be utility-like in their performance.

4] Drivers of PLM - refer section (2).

5] Conceptualization

Any product that is available in the market is first conceptualized, which is an initial step that has to be followed during the product developm--ent. During conceptualization following are the general questions that may arise.

→ Is there a need for the product ?
→ What are the requirements the product must meet?
→ How are there requirements can be mapped as the specifications ?
→ what would be the overall cost the organisations has to bear in order to manufacture that product. ?

The requirements for the product is directly obtained from the customers but in some cases the requirement would arise indirectly during the marketing of the existing product.

The organisations must have a focus on the cost cutting parameters in processing of the product and should have conceptualization about a product that satisfies all the needs of the customer.

The factors which needs to be considered at the conceptualization stage falls into 3 categories.

* Functional performance : motion, kinematics, force/torque, energy conversion/usage and Control.
* Operating environment : Air temperature, pressure, humidity, contaminants, shock and vibration.
* Safety and product factors : Economic, geometric limitation, maintenance, repair, retirement, reliability, robustness, pollution, human factors, and appearence.

The outcomes of Conceptualization are
→ An activity analysis list.
→ A functional decomposition diagram.
→ A technical specification list.
→ A product modular decomposition diagram.

Steps in conceptualization

Step	purpose	Tools
Search Externally	* Aimed at finding existing solutions to satisfy the specifications indentified in the previous stage * The external search is essentially an information gathering process.	* Interviews * Consult experts * Search patents * Search published Literature * Benchmarking
Search Internally	* Internal search uses personal and team knowledge and creativity to generate solution concepts.	* Induvidual discussion * Group discussion * Review of relevant past cases.
Explore	* A systematic exploration of alternative solutions results in a synthesis of solutions fragments	* classification tree * Morphological chart * Concept combination table

6) Design

In conceptualization stage the concepts are usually expressed as a set of sketches or rough 3-d models accompanied by brief textual descriptions.

Designers critically examine data from conceptuali-zation for it's feasibility and possibilities for further improvement.

The general conceptual design developed by the concept engineers is taken up by product design engineers and they completely specify it according to the engineering norms and conditions.

→ The product engineer must also make sure that all the various components fits together in an integrated system and that system is internally consistent.

-> To improve product development process, new products are created by combining (or) modifying the existing designs. Reusing existing designs is more cost effective and time saving.

-> Outsourcing of design work is also a major contributor to gets things done faster.

-> Once the design is completely specified the product design engineer must run various tests such as force, flow analysis on the entire component so as to ~~meet~~ insure that product really meets all the mandatory specified functional requirements.

-> The tests can be conducted on prototypes or in a virtual space.

Following table depicts Design activities and Tools

Activities	Tools / Methods
Search	* Data Vault [past designs & related information] * Design pattern recognition & analysis. * On-line catalogues.
Write	* Word processor.
Sketch & Design	* Sketching tools, CAD * Recalled existing design patterns & modules with modification tools.
Analyse	* Spread sheets * Flow charts * Analysis softwares * Quality function deployment [QFD] * Engineering design specification tools.

Discussion decision-making and review.	* Voice and video playback * Digital white board. * progress charts * presentation tools.

7] Build / Development

Once the product is fully specified it's the role of manufacturing engineering to determine how the product must be built.

The designs must be analysed and the Bill of Processes [BOFP] should be developed to specify what operations need to be done in what sequence to create a specified part.

The produced parts must be then assembled in a specific sequence to develop the complete ~~the~~ product.

8] Validation

The process of validation is defined as the collection and evaluation of data, from the process of design stage through commercial production, which establi--shes the scientific evidence of assurance of that a product, service, or system meets the needs of the customer and a process is capable of consistently ~~deld~~ delivering quality product.

Process validation involves a series of activities taking place over the lifecycle of the product and process. Process validation is framed into three stages.

Stage 1: process design: The commercial manufacturing process is defined during this stage based on the knowledge gained through development and scale-up activities.

Stage-2 : Process qualification : During this stage, the process design is evaluated to determine if the process is capable of reproducible commercial manufacturing

Stage-3 : Continued process verification : Ongoing assurance is gained during routine production that the process remains in a state of control.

A successful validation program depends upon information & knowledge from product and process development. This knowledge and understanding is the basis for establishing an approach to control of the manufacturing process that results in products with the desired quality attributes.

Manufacturers should

→ Understand the sources of variation.

→ Detect the presence and degree of variation

→ Understand the impact of variation on the process and ultimately on product attributes.

→ ~~Control the variations~~ on the process and ~~ultimately on product attributes.~~

→ Control the variation in a manner commensurate with the risk it represents to the process and product.

9) Production / Manufacturing.

The manufacturer should first Judge whether the organization has gained sufficient understanding to provide a high degree of assurance in it's manufacturing process and has to Justify commercial distribution of the product.

In most of the organisations there are three basics distinct phases that is followed during manufacturing.

i) Building the first product
ii) Ramping production up
iii) Building up the rest of the products.

In manufacturing a first product there are two considerations.

i) Building it in a new plant
ii) Building it in the existing plant.

If the product is to be built in the new plant it has to be substantially more complicated. If the product has to be built in existing plant then the production/manufacturing engineers should determine how to manufacture the part with the available tools and equipments in the existing plant.

Once the manufacturing and production department recieves the product information they continuously try to optimize and refine the production plans with ramping up, and generate a bill of process to build the parts and products using available resources in the plant.

Manufacturers should also use ~~org~~ ongoing programs to collect and analyze product and process data to evaluate the state of control of the process.

10) Support of PLM : Refere section 3 @ (iii)

— The end —

PRODUCT LIFE CYCLE MANAGEMENT

UNIT 3 : Product Data Management [PDM] Process and Workflow

PDM system and Importance, reason for implementing a PDM system, financial justification of PDM implementation, Versioning, check in and check out, views, Metadata, Life cycle and Workflow, Applied problems and solution on PDM process and workflow.

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1) Introduction

product data and PDM systems

→ product data is understood to encompass all the data connected with products. Much of the data managed inside a manufacturing company can be regarded as product data.

→ corporate functions that deal with data other than product data include financing and human resources, and possibly also manufacturing resources.

→ PDM systems are about managing product information throughout the entire lifecycle of a product, in a more efficient, organised way.

→ PDM assists in successful implementation of a concurrent engineering strategy through provision of the mechanisms to capture and enforce the specific product development process consistently and according to the way a company does the business.

→ PDM system ~~Consists of information~~ manages all product related information, such as manufacturing products, motor vehicle, computers, and mobile phones, projects such as buildings, bridges, and motorways. PDM also manages design applications such as geometry, engineering drawings, project plans, part files, assembly diagrams, product specifications, and numerical control machine tool programs etc.

→ PDM provides foundation to improve product development and engineering performance.

→ PDM enables information sharing with other parts of the business that play important roles in developing high quality, profitable products. ~~In fact,~~.

→ As PDM gets established, other departments such as manufacturing, quality, purchasing, sales, and marketing frequently recognize the value of extending PDM to manage their product related information. These improvements rely on foundation of accurate, current engineering data.

→ Today PDM has become a mission critical initiative that enables faster, more efficient and effective product development by managing and sharing product data ~~and~~ across departmental boundaries.

Basic functionalities of a PDM system

1) Secure storage of documents and other objects in a database with a controlled access

In many companies the first motivation for considering PDM comes from people frustrated from not being able to find documents they are looking for.

The people may only know that the needed documents are located somewhere in a network of a file servers.

There may ~~be~~ even be many copies of a document at different locations, and in the worst case two people can make conflicting changes in two copies of the same document.

2) Mechanism for associating objects with attributes

The properties of documents and other objects are described by means of attributes. The attributes provide necessary information about an object, and they can also be used for finding objects.

3) Management of the temporal evolution of an object through sequential revisions

The PDM systems are originally developed for the design and development environments. In such environment users typically spend more time modifying existing designs than creating completely new designs. The evolution of ~~of~~ drawings and other design objects is usually captured in the form of successive revisions.

4) Management of alternative variants of an object

Many products and documents ~~are different~~. have alternative variants. Ex: A user guide's for a particular product can be available in different language, A same car can come in both petrol and diesel version.

5) Management of inspection and release procedures associated with the objects.

Documents and other objects with engineering data must typically be checked and approved with more or less elaborative procedures before the objects are released for general use.

Ex: Preparation and disclosure of user manual of a product before launching it. Documenting and disclosing necessary information about product service, to the service centres. etc

6) Management of the recursive division of an object into smaller components

Hierarchial division of product structure data into several components and furthur subdivision of it into smaller components.

Ex: Considering Petrol engine as our main component the fuel supplying system may be considered as sub component of data. And fuel system contains data of further sub-division of data containing information of Type of carburetter, Type of fuel injection system, Air fuel mixture ratio etc.

7) Management of changes that affect multiple related objects.

One of the primary functions of PDM system is to support change management. In their basic form the revisions and variants represents the changes of seperate objects. Nevertheless, it is often also necessary to view a set of related objects as a single unit with respect to the change management.

Ex: After launching an Automobile, there will be time to time revision and re-engineering [Adding additional features such as CRDI, disc brakes, ~~ABS~~ ABS (or) Cosmetic change] of product which needs to be documented in order as a single unit.

8) Management of multiple views of an object

A PDM system should make it possible to have different views of an object.

Ex: A customer point of view, supplier point of view Etc.

9) Management of multiple document representations

A PDM system should also make it possible to

store a document in multiple different representations ③
Ex: A drawing created in (or) with a CAD tool can be available in the native file format of the tool and in a neutral file format for viewing and printing.

10) Viewing tools

In addition to simply displaying the read-only representations, some viewing tools allow users to insert textual and graphical annotations on top of the document without modifying the original data.

11) Tool Integration

From an ordinary user's point of view, the usability of a PDM system depends very much on how well the system is integrated with other tools that he or she needs in his (or) her daily works.

12) Component and supplier management

The management of standard components bought by a company from external suppliers is a rapidly growing field within PDM.

② Importance of PDM (or) Advantages of PDM

-> As companies come under increasing competitive pressures, they are required to reduce lead times, reduce costs and increase quality.
-> The product development activity of the company is a prime target for action to achieve these targets. product development is the activity that has the major influence on the time taken to get the product to market.
-> Also product development has major influence on the pr cost of the product. Although only some 10% of the total cost is actually incurred during design and develop-

stage, some 75% of costs are defined during these activities.

-> Since the quality of the product delivered to the customer is in a many ways a function of the quality of the product defined during the product development, it is here that the major improvements to product quality must be made.

-> product development is an upstream activity. If mistakes occur upstream, the downstream functions, such as shop floor operations, will suffer.

-> By improving the control of product information and activities, PDM systems help reduce lead time, reduce costs, and improve quality.

-> Reduced lead times improve profits and open up new market ~~activities~~ opportunities. They also reduce market risk by reducing the time between product specification and product delivery. The sooner the customer use a product, the sooner their feedback can be incorporated in a new, improved version.

-> PDM will improve Product development productivity. The product development managers will know the exact design status. They will be able to assign resource better, and release designs faster and with more confidence. Design engineers will know which parts are available and which procedures should be followed when designing new parts.

-> Manufacturing engineers will be able to see how similar parts were produced previously.

<u>The advantages of PDM are</u>

* Track and manage all changes to product related data.
* Spend less time organizing and tracking design data.
* Reuse of product design data to improve productivity.
* Enhance Collaboration with other industries
* PDM helps companies realize their targeted market position.

* Better work processes and good access to product data reduce expensive and late changes improving change management.
* Better product quality can be achieved using consistent and up to date data, better checking and fewer errors.
* Improved speed and flexibility from being able to call up CAD files instead of searching design offices for paper drawings.
* Desired efficiency can be achieved through creation of a cost effective computing infrastructure that supports a distributed multidiciplinary collaborative style of work.
* It creates an environment that automates management of work by integrating people, their tools, processes and information.
* PDM can be used for other non-engineering sectors such as publishing, software development, financial services or any environment where product information and processes will benefit from better control.
* Implementation of PDM helps in globalization of the product development efforts to take advantage of resources around the world.

3] Reasons for implementing a PDM system

The reasons for implementing a PDM system can be divided into two classes.

a) The PDM system appears to alleviate some of the problems that occur in the product development environment.

b) It appears to proactively and positively impact ~~opportu-nities across~~ operations across the product lifecycle.

-> The first class of reasons includes those in which the PDM system is used to overcome currently existing problems. Many of these reasons are related to the rapidly increasing amount of data in Product development Environment.

→ The increased computerisation of product development activities leads to an increase in the volume and availability of product data.
Without PDM system these information can't be managed effectively.

→ Among the reasons for PDM that fall in the category of positively impacting operations are

* Better use of resources
* Better access to information
* Better reuse of design information
* Better control of engineering changes
* A reduction in design cost
* A reduction in lead time
* Improved security of product information.

→ PDM systems helps companies improve their competitive edge.

* They help improve the productivity of product development stage (or) process.
* They allow companies to be more flexible in their manufacturing.
* They help companies to improve the quality of their product
* They allow companies to be more adaptable to market requirements.

→ The two classes of reasons for using PDM are very closely linked. The reasons can be grouped into categories as.

(a) <u>Information management</u> [Controlled secure storage and management of product data in a database].

One of the primary PDM functions, In ERP systems it could be accomplished through common enterprise database, like Oracle in Oracle based systems.

with such implementation, access control is easily adressed through database management system on user level. Under management of design data are considered check-in and check-out functions for tracking design data changes.

(b) Workflow and process management

Although every ERP systems have modules for production workflow and production process management, in PDM systems such functions are dedicated to manage processes and workflows used to modify and control the product i.e. to manage Engineering Change Order [ECO] by tracking approvals and authorizations of changes to product data.

(c) product structure management

As one of the basic property of almost any product, a heirarchial product breakdown structure is considered. It describes how product is divided into components, which are inturn divided in to subcomponents etc.

(d) classification of parts

PDM provides information on standard components and helps in reuse of designs. PDM systems integrated with ERP system provide Just-in-time relationship with suppliers of components based on product design demands.

(e) Program management

PDM systems helps in better work breakdown structures and allows coordination between processes, resource scheduling and project tracking.

(f) Automation of product development activities

(g) Improvement of information system effectiveness

(h) Infrastructure for effective product development etc.

7) ~~Financial Justification of PDM Implementation~~

Note : ERP [Enterprise Resource Planning] : is business management software - typically a suite of integrated applications - that a company can use to collect, store, manage and interpret data from many business activities, including : product planning, cost. Manufacturing or service delivery, marketing & sales

Concurrent Engineering : is a work methodology based on the parallelization of tasks [i.e performing tasks concurrently]. It refers to an approach used in product development in which functions of design engg, manufacturing engg. and other functions of are integrated to reduce the elapsed time required to bring a new product to the market.

Lead time : Lead time is the latency between the initiation and execution of a process. For example the lead time between placement of an order and delivery of a new car from a manufacturer may be anywhere from 2 ~~week~~ weeks to six months. In industry, lead time reduction is an important part of lean manufacturing.

4) Components of a PDM System

i) The information warehouse or vault. This is where product data is stored.

ii) The information management module which manages the information warehouse. It is responsible for such issues as data access, storage and recall, information security and integrity, concurrent use of data, and archival and recovery.
It provides traceability of all actions taken on product data.

iii) The user interface. This provides a standard but tailorable, interface for users. It supports user queries, menu driven and forms driven input and report generation.

iv) System interface for programs such as CAD and ERP

v) Information and workflow structure definition functions which are used to define the structure of the data and workflows to be managed by the PDM system. The workflow is made up of set of tasks. Data such as resources, events, responsibilities, procedures and standards can be associated to these tasks.

vi) Information structure management functions that maintain the exact structure of all information in the system across the product lifecycle

vii) Workflow management functions that keep workflow under control, for example managing engineering changes and revisions.

viii) System administration functionality which is used to set up and maintain configuration of the system, and to assign and modify ~~access~~ access rights.

5) Financial Justification of PDM

Every year, companies have the opportunity to invest in a variety of new on-going short term and long term projects, such as Introducing new products, Improving manufacturing productivity, Developing the corporate image, Improving work conditions, Implementing PDM. etc.

Top management has a difficult task in choosing which project to fund, Most of the projects are

-> Will appear very important.
-> Will often involve a large initial investment.
-> Have a major effect on the company in long term.
-> Has the potential for creating major upheavals.

Top management is unlikely to understand the project in detail, and so will be heavily influenced by the people proposing the projects and the written proposals.

When PDM project is presented to management, it should contain a financial investment and running cost associated with the investment, and the effect of the investment on other areas of the company.

Some of the basic parameters to be considered to financially justify the PDM system in an organisation are
* Time value of money
* Net present value
* Identification of the benefit
* Cost Justification
* problems associated.

* Time value of/or money :

-> This term describes the fact that $ 100 received this year does not have the same value as $ 100 received in previous (or) future years.

-> If the $ 100 received this year be invested at a fixed 10% annual interest rate, then in one year it will be worth $ 110 and in five year $ 161.051.

-> The time value of money has to be considered when calculating the costs and benefits that occur in different years of a PDM project.

-> To make the values in project calculation easier to compare, all future values are converted to their value in the present [i.e year zero of the project].

-> The above technique of working backwords from a future time at which a value is known, to find it's present value, is called discounting.

-> If the project is of 5 year span, to calculate the present value of cash inflows of a five-year project, an expected interest rate has to be chosen.

-> This rate will be used to discount the cash inflows.

-> A similar calculation could be carried out for the cash outflows of the project.

-> Once the discounting calculations are carried out for cash inflows and outflows. It is easier to see whether the project is going to meet management requirements.

-> Several methods are used to express the profitability of different projects in understandable and comparable terms.
i) Accounting rate of return (ARR) ii) Payback time iii) Net present value (NPV) iv) Discounted cash flow (DCF) v) Return on investment (ROI)

* Net present Value (NPV)

→ The NPV of a project at any given time is calculated by subtracting the sum of discounted cash flows up to that time from the investment.

$$NPV = -I + \sum_{t=1}^{n} \frac{(R_t - C_t)}{(I_0 - D_e)^2}$$

where I - Investment in the year 0
n - project lifetime in years
R_t - Revenue in the year t
C_t - Cost in the year t.
D_e - Discount rate.

→ When the NPV is +ve the DCFs are greater than the initial investment, so the project is making more than discount rate in use.

→ If the NPV is negative, then the project is making less than the discount rate in use.

→ Since the organisations are more concerned about the investments, it's better to always have an estimation of the exact returns i.e Return on investment [ROI].

→ Risk analysis is carried out to estimate the probability that the ROI will be met.

* Cost Justification :

There are three major areas of PDM cost Justification to describe - Costs, benefits and the Overall approach.

Identification of cost involved in the project is not too difficult. They are generally divided into initial Investment Costs and on-going Costs.

Initial investment include

-> Initial investment in PDM system software.
-> —— " —— complementary software if required [Database management system]
-> Initial investment in Hardware for the PDM system.
-> awareness training & education.
-> consultancy etc.

On-going costs include

-> PDM system software renewal, maintenance costs.
-> Complimentary software renewal & maintenance costs.
-> Furthur investment in Hardware
-> Communication charges
-> modification of existing procedures etc.

In addition to above costs, there is another set of costs that needs to be understood. These are the costs of doing business without PDM. Reduction of these costs is a source of potential benefits. These costs include

-> Labour costs
-> Quality costs
-> Cost of introducing new products.
-> Cost of modifying existing products
-> field support costs.

The benefits expected from PDM system is in the form of reducing above mentioned costs.

Basically there are two types of benefits possible, One is to reduce costs & other is to increase revenues which include

-> reduce no. of product developers in process
-> reduce the cost of quality
-> reduce documentation costs.
-> reduce energy consumption.
-> reduce finished ~~costs~~ stocks.
-> reduce cost of storing information
-> reduce warranty costs
-> reduce penalty works
-> reduce ~~rework~~ ~~Costs~~ rework costs.

* **Identification of benefits**

The major difficulty in the financial justification of PDM process is identification of the benefits. One can think of having a multi-level structure with the overall business benefits at top level and more detailed benefits at the lower levels. But the overall business benefits of the PDM systems are divide. for the organisation can results from addition of all the detailed benefits.

In order to calculate the overall benefits resulting from PDM, the "costs of the PDM" system has to be subtracted from the "benefits or profits of the PDM" system.

Again the benefits are divided into two parts - increase in revenues resulting from the introduction of PDM and decrease in costs due to the introduction of the PDM.

* **Potential problems**

Many potential problems can occur during the implementation of the PDM system. For ex: the organisation may set self objectives to reduce of lead time, reduce costs and improve the quality of the product.

Also one should check the mentality of the labours to take up the changes in the routine work before implementation of these PDM systems, which would otherwise lead to a major problem once the PLM system have been implemented.

6] Versioning

All PDM systems allows an object to have many seperate versions. Versions are mainly used for two basic concepts. Firstly, versions can represent the evolution of an object through successive stages; these versions are often called revisions, secondly, an object can have a number of parallel alternatives. Versions of this types are often known as variants.

Revisions

-> An engineering document must be modified even after the document has been released.

-> A document typically describes some aspect of a product manufactured by a company, and no company remains competitive without constantly improving it's product's through new versions.

-> Hence when a released document is modified for improving, the users of the document should be exposed to the modifications in a controlled manner to minimize the inevitable disruptions since it is very likely to disturb the work of many people.

-> During the lifetime of a product document when a product and related documents are modified, it is necessary to save the old revisions of the documents so that the manufacturer knows that what the earlier manufactured products were like. This information is essential for after sales ~~such~~ operations such as maintenance and modernisation.

Variants:

-> In ~~order~~ addition to sequential revisions, an object can have a number of parallel variants.

→ The variants can, for example represents different customer groups and marketing areas.

Ex: A manual can be available in different languages or an electric applaiance can be manufactured for different voltages.

→ The basic difference between revisions and variants is that a new revisions of a document (or) product replaces older revisions whereas all variants of a document (or) product are available at same time as ~~variants~~ alternatives.

Ex: A design modification (or) improvement of an automobile replaces the old design, but the different variants of an automobile i.e petrol and diesel variants of same product are available at same time.

→ In addition to the variants with different contents, a digital document may have different alternative representations. For example, a CAD drawing can be stored in the "native format" i.e as a file can be directly manipulated with the CAD tool.

→ At the same time a CAD drawing can also have read-only representations in generally available standard formats that make it possible to display and print the document without the original tool. may be a JPEG (or) PDF file [PDF = portable document format].

<u>Version tree and graphs</u>

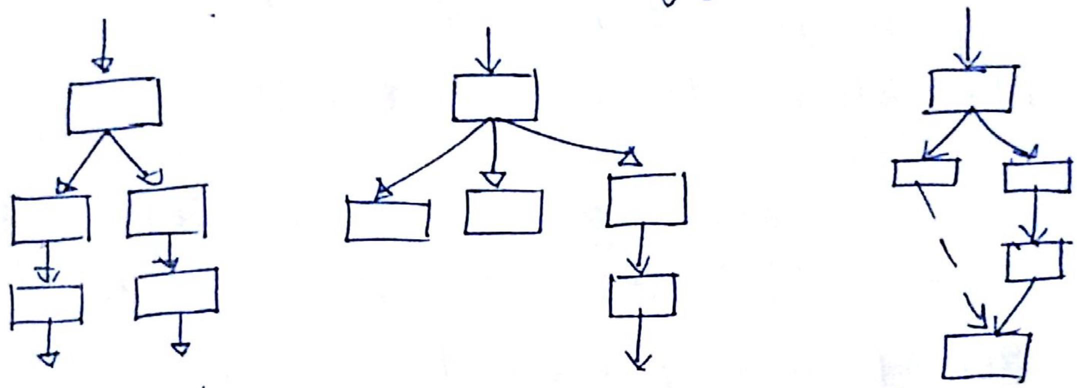
→ Different revisions and variants can be represented in a version tree as follows.

→ A branch, for example represent a parallel line of development that will co-exist with the original line as a new variant (figure a)

→ Branching can also be used for creating multiple tentative alternatives, one of which is eventually chosen for further development (figure b).

→ Versions that were originally created as tentative alternatives can of course later change to become variants and vice versa.

→ A new version may be formed by combining two or more old versions. (figure c)



a) Branching for a new variant b) Branching for tentative alternatives c) Branching and merging.

Versioning is only about making change in the content. [3D model, drawing, source code, assembly, configuration etc].

The role of PDM software is to capture the change and make it available for history tracking.

7) <u>Check in and check out</u>

<u>Check in</u> ⇒ By default, the PDM system allows designers to download the latest version of a product design from the server.

-> In order to modify a design a user must check out the design and copy all of it's dependent objects from the server.
-> The process of checking out communicates the user's intention to modify a design to the server.
-> While a design is checked out, only the user who checked out the design can modify it.
-> All other users are permitted only to download a read only version of the design, thus the integrity of the design is maintained.
-> when the designer who has downloaded the document for modifying it finished his work and now wants to share it with others he has to perform a check-in operation.
-> The check in process signs, dates and stores the object on the PDM server alongside the old data.

Typically the user will use the workspace to checkout design information from the PDM server and to check in modified design. However, the workspace will also allow the user to,
-> perform basic PDM operations such as upload, checkin, Download and check out.
-> Display and sort active objects ~~tat~~ that an user have either downloaded or checked out.
-> Configure the display of new, downloaded, (or) checked out objects.
-> The objects are displayed in a tabular format.
-> Each row represents an object.
-> Each column represents an attribute of an object.
-> Each column can be sorted independently. etc.

8]. Views

From customer needs to detailed design, simulation and test, manufacturing engineering, and service support, each engineering discipline needs access to different views and levels of representation (of data).

For example, a system engineer will not be interested in the ~~object~~ details of design implementation, but will have to check that requirements have been properly expressed, matched and tested.

The key enabling factor relates to the ability to identify the decision variables, which must be defined at a high level of abstraction to reconcile different views and support a sharable representation.

At a high level of abstraction, the sharing of the product definition may resolve the difficult challenge of maintaining consistency and accuracy.

9] Meta data

The meta data: is information about information.
Meta data describes the product data: what kind of information it is, where it is ~~locatied~~ located, in which data bank, who has recorded it, and where and when it can be accessed?

Example: A digital image may include metadata that describe how large the picture is, the color depth, the image resolution, when the image was created, and other data.

Example: A text document's metadata may contain information about how long the document is, who the author is, when the document was written and a short summary of the document.

The concepts of product data or information model & product model, for which the term product structure is nearly always used as a synonym, and the acronym BOM (Bill of materials) are also closely connected to the product data.

→ Actually BOM refers to a manufacturing part list (i.e not a heirarchial structure), so it is not strictly speaking the same as a product structure.

→ The part list is typically a single-level, flat list of the necessary components used by the manufacturer in assembling the product.

→ The list does not contain a product structure, assembly or component heirarchy.

→ Historically product data management systems primarily focused on managing engineering drawings and CAD files in the design phase of product development.

→ However this view has been expanded to include more activities throughout the product lifecycle ranging from early design phases to product maintenance.

One of the problems encountered in PDM is the standardisation needed to exchange data of different types and formats between the diverse applications.

→ This is where we need to use Metadata approach which must rely on a mechanism to represent the data exchanged whatever format it is, to convert it to a standard meta data format. and to ensure it's proper exchange between ~~part~~ partners where it can be reconverted to it's original format and processed conveniently.

→ Achieving this aim requires the use of a methodology that is adaptable to the current situation and extensible enough to meet future requirements and new technologies as they emerge.

→ To ensure broad application, the technology needs to be widdly and freely available.

The Extensible Markup Language (XML) developed by the world wide web consortium provides such a freely available, widely transportable methodology for well-controlled data interchange.

XML and it's related document object models (DOM) standards are provided with mechanisms to access and manage data represented in XML.

10) Lifecycle and Workflow

A workflow consists of a sequence of connected steps where each step follows without delay (or) gap and ends just before the subsequent step may begin.

Workflow is a depiction of a sequence of operations declared as a work of a person (or) a group, an organisation (or) staff, or one or more simple or complex mechanisms.

Workflow may be seen as abstraction of real work. or virtual representation of actual work. The workflow being described may refer to a document (or) product that is being transferred from one step to another.

Work flow management system

A workflow management system is a computer system that manages and defines a series of tasks within an organisation to produce a final outcome or outcomes.

Work flow ~~mang~~ management system allows the users to define different workflows for different types of Jobs and processes.

For example, in a manufacturing setting, a design document might be automatically routed from designer to a technical director to the production engineer.

Workflow management systems also appear in distributed IT environments such as Grid computing or cloud computing. The aim of such system are to manage the execution of variours processes that may belong to the same application while in many cases they are used as a means to guarantee the offered quality of service [QoS].

Workflow components

The workflow can usually be described using formal or Informal flow diagramming techniques, showing directed flows between processing steps. Single processing steps or components of a workflow can basically be defined by three parameters.

1) input description: the information, material and energy required to complete the step.
2) Transformation rules, algorithms, which may be carried out by associated human roles or machines, or a combination.

3) Output description: The information, material and energy produced by the step and provided as input to down stream steps.

Work flow improvement techniques

Several workflow improvement theories have bean proposed and implemented in the modren workplace. These include:

- → Six sigma.
- → Total quality management.
- → Business process Reingineering.
- → Lean systems.
- → Theory of constraints.
- → Neutral Workflow.

Functions of work flow managgement systems

a) Make sure the most appropriate process is followed:

b) clean-up product development: To eliminate duplicates, bottle necks, ~~unnessa~~ unnecessary and non value adding activities.

c) Get control of product development. and make sure the things are done properly.

d) Improve resource utilisation & project coordination.

e) Improve product status visibility and Regarding information

f) Provide information security by controlled access.

g) provide the basis for automated product development.

h) Reduce product development cost & product development cycle time

i) Reduce repeated works and reworks
j) provide the benefits of electronic information sharing.
k) Reduce the volume of paper in circulation.
l) Make sure that information is available when needed.
m) Bringing geographically distinct engineers together in a virtual environment.
n) Help reduce no. of face to face project meetings and ensure specific procedures are followed.
o) Help manage engineering change process and automate uninteresting procedures.
p) Improve communication between different team members.
q) Maintain active interaction with people to achieve corporate objectives.

II Applied problems and solutions on PDM processes and workflow

The communities of PDM are struggling in solving some currently available challenges: They are

-> Successful implementation of PDM system.
-> static and unfriendly graphical user interface.
-> static and unintelligent search
-> PDM system Deployment and Reinstallation
-> Secure and scalable
-> platform independent system
-> standardised framework.

(a) Successful PDM system implementation:

-> Successful implementation of a PDM based applications in especially large organisations is a quite difficult, time consuming, expensive and complete task.

It becomes more hectic with respect to the implement point of view when most of the time most of the staff (from corporate management, top level management, engineering management and IT department) do not give importance to the PDM products and without these person's co-operation it is quite difficult to gather system requirement based information for PDM based system ~~based~~ design implementation.

Most of the people don't want to use PDM based ~~implementation~~ applications because they are afraid for several reasons like top level managers don't want to involve in low level technical & business issues, don't want to spend more money, don't have much time, look for fast payback projects and think that PDM based applications are not matured enough, non-flexible and risky to consider, where as the operational level staff is sometime incapable of handling PDM systems and feel Job insecurity.

(b) Static and Unfriendly GUI [Graphical user interface]

→ The graphical user interfaces of available PDM based applications are unfriendly and due to this problem it is very hard for a new user to learn and play in short time.

→ Moreover existing PDM based applications GUI are static, not flexible enough to redesign, slow in event handling and not much intelligent so then it can automatically learn and redesign itself according to the user's use and need.

c) Static and Unintelligent search

-> In every PDM based application, there is a search mechanism required and implemented to locate the user's needed information.

-> But unfortunately as yet there is no such intelligent search mechanism available which can process user's dynamic request based queries and can extract the most optimised results in minimum possible time in return.

d) PDM system deployment & Reinstallation

-> PDM based products (softwares) are very big and complex heavily depending ~~on~~ upon many third party software for the implementation. and due to this reason it's very hard to install full application at once.

-> Moreover PDM systems are required to be easily extendable because wheever new features are demanded users must ~~in~~ most of the time in most of the cases have to reinstall or upgrade the client application completely.

e) Secure and scalable

-> Traditional PDM systems are not adequately available, secure, reliable and scalable for global enterprise services.

-> Because of highly important technical and managerial data storage and management, it's very important that the PDM system should be highly secured, reliable & scalable. So that it cannot easily be hacked and destroyed.

f) platform independent system

-> PDM systems are required to be platform independent because in the new business model, it is nearly impossible to mandate that all the potential users choose the same platform or the same operation system.

-> Moreover homogenous network configured PDM needs to provide access to all users placed at different locations, especially those who are on different networks.

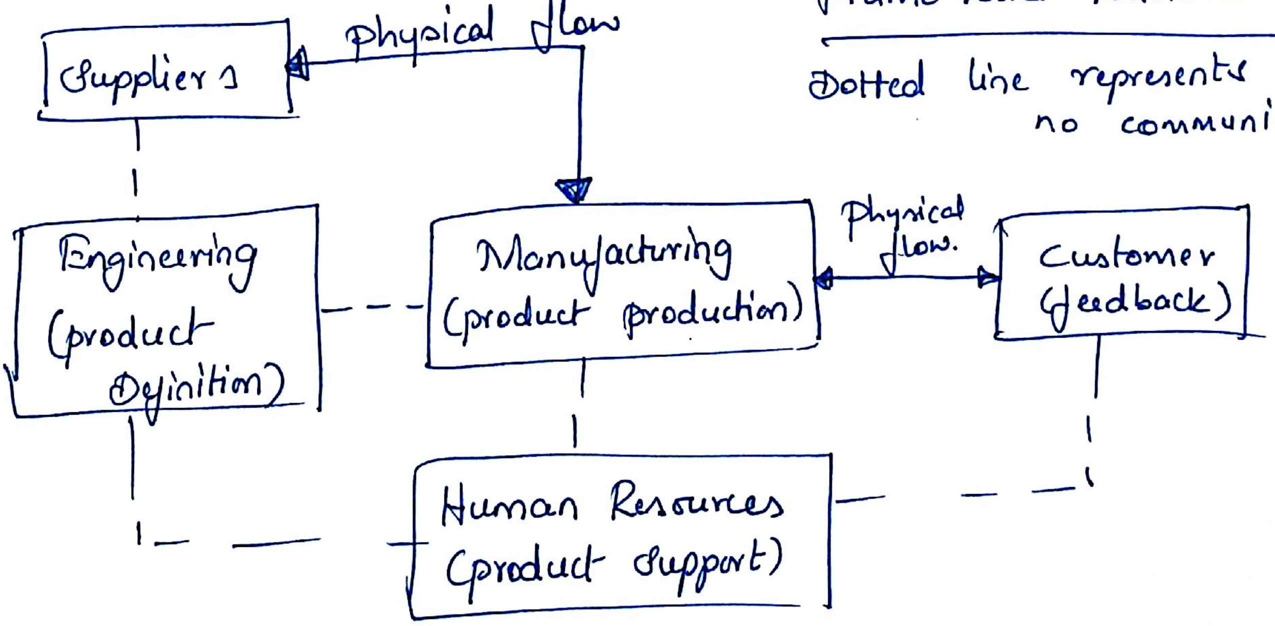
g) Standardised Framework :

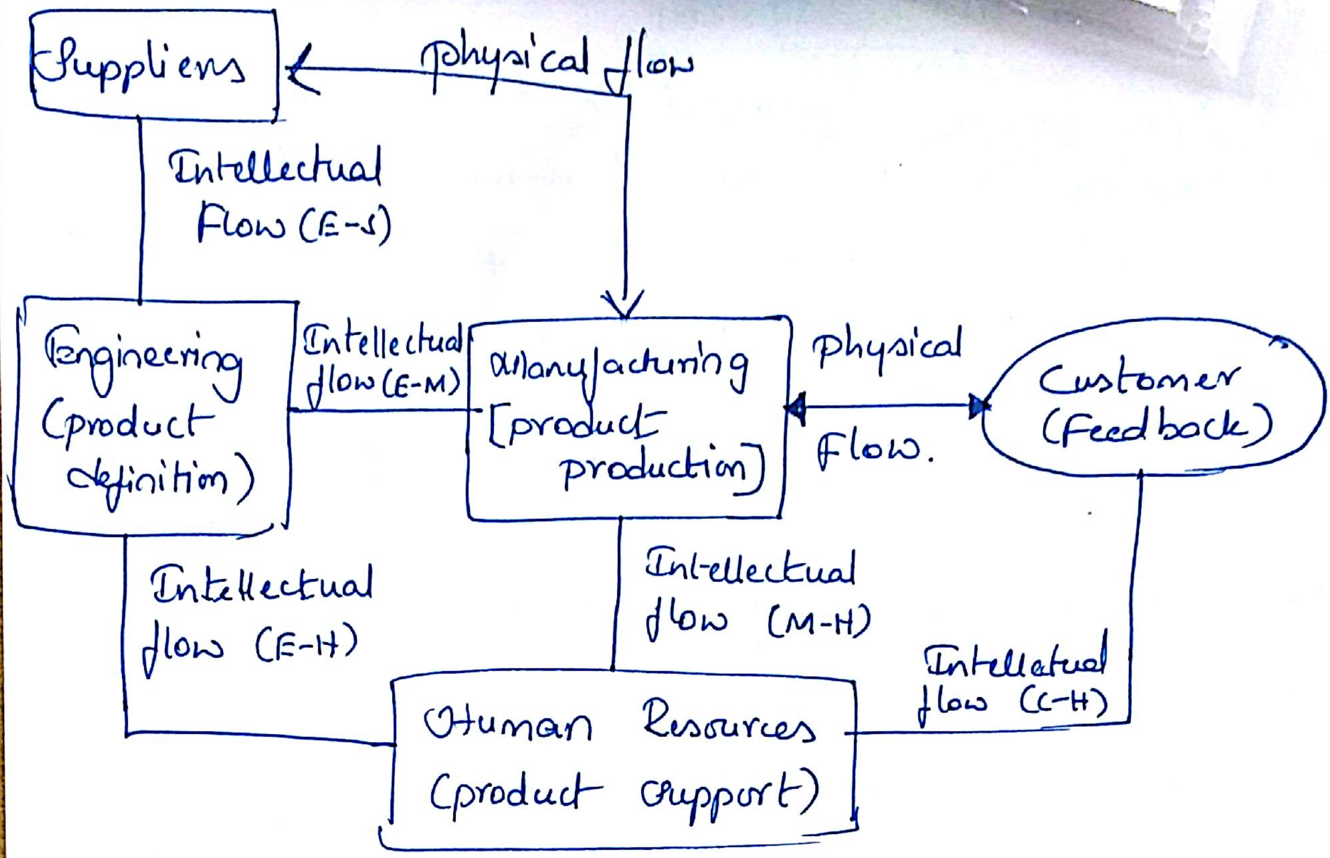
-> These days many companies are developing many different PDM systems keeping almost similar goals in their minds but using different framework.

-> It will be a great favour to PDM system development community if there will be a standardized framework PDM systems development.

Frame work without PLM

Dotted line represents no communication.





PLM Framework

E-S = Materials, negotiations, requirements compliance
E-M = BOM, tooling, product test, MRP.
E-H = plan of service, Launch plans, web strategy.
M-H = product release date, Web strategy.
C-H = Updates, customer feed back, design-to-order.

—— The End ——

PRODUCT LIFE CYCLE MANAGEMENT

UNIT : 7 - DIGITAL MANUFACTURING

Syllabus : Digital manufacturing, benefits of digital manufacturing, manufacturing the first one, Ramp up, Virtual learning curve, manufacturing the rest, production planning.

I] Introduction

The objective of the manufacturing function is to produce a product with precisely defined specifications and tolerances utilizing the least amount of resources.

There are three distinct phases of the manufacturing function

* producing the first product
* Ramp up
* Producing the rest of the products.

Digital manufacturing is the subset of PLM that focuses on producing a product that consistently meets the specifications, yet does so using the minimum possible resources from the first product on.

Definition: " Digital manufacturing is an approach involving people, process/practice, and technology that uses PLM information to plan, engineer and build the first instance of a product, Ramp that product up for volume production, produce, monitor and capture for other aspects of life cycle the remaining instances of that product's production using the minimum amount of resources possible."

Salient features of digital manufacturing [DM]

-> In digital manufacturing [DM], there will be more focus on technology aspect because computer technology is what puts the digital into DM.

-> The focus on technology also differentiates DM from manufacturing techniques and DM attempts to to minimize the resources used in manufacting and also DM is more people oriented ~~such as~~ through implementing lean manufacturing.

-> people also figure differently in DM. Their involvement can vary considerably in building the product. In some manufacturing process people may figure very little, with machines and robots performing a substantial portion of the actual production.

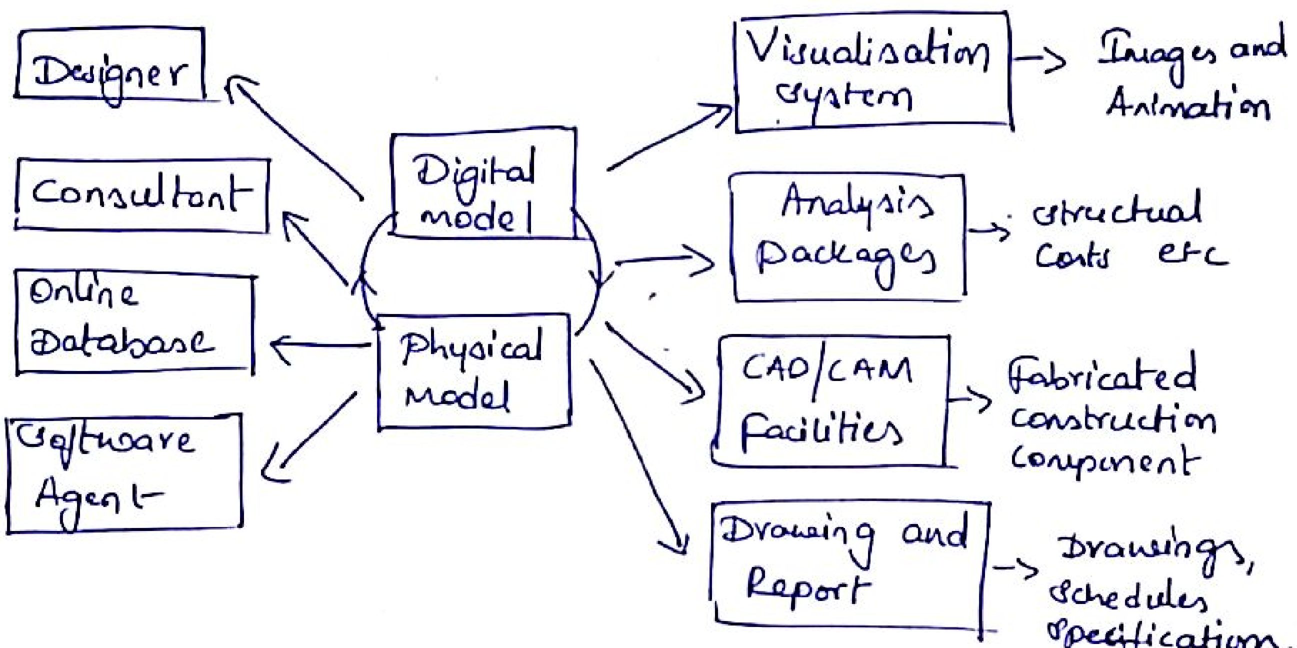
-> DM is better suited to more automated manufacturing processes. DM involves design, simulation, optimisation, analysis and offline programming of robotic and al automated manufacturing processes. such as

* Modelling of complex kinematics of robots and other mechanisms
* 3-D layout definition of work cells
* Modelling and optimization of the whole manufacturing process i.e SOP [standard operating procedures]
* OLP [offline programming] helps in optimized programs downloaded to robots on the shopfloor, etc.,

-> DM is involved in the planning and engineering tasks necessary to build the product to it's specifications.

-> Where DM shows ~~promising~~ greatest promise is in using the minimum resources possible through simulation of all aspects of a product's manufacture, DM makes use of information as a trade-off for saving time, energy and material.

-> In addition, DM can send feed back to design and engineering it's information about manufacturability of a product. This inturn reduces the errors, the time to correct errors that do crop up, and prevent designs that cannot be manufactured.



The Integrated Roles Towards a Digital Model

-> DM focuses on Integrating the information from different applications with it's own system. It is this integration of information across functional areas that differentiates DM from other earlier point solutions that performed process planning, shop-floor scheduling, or some simulation tools etc.

-> DM taps into the info core and draws out the product information from design and engineering. Feeds back information to help and refine and validate the product design. Feeds forward information about how the product was manufactured to aid in it's use and disposal.

→ While a distinct entity on its own, DM requires the PLM framework in order to be successful.

3] Benefits of Digital manufacturing

→ The output of manufacturing i.e the product with certain specifications is well defined using DM.

→ The inputs of manufacturing i.e material, machinery, people and energy are also well defined using DM. Thus the process necessary to produce the output while minimising the inputs are amenable to analysis and optimization.

→ Digital manufacturing can help manufacturing companies improve their productivity in both manufacturing and production planning process.

→ Digital manufacturing enables product, process, plant and resource information to be associated, viewed and taken through change processes, with a consistent and comprehensive approach to production design.

→ DM allows part manufacturing processes to be optimised within a managed environment. One can produce flexible work instructions capable of displaying 2D/3D part information along with machining and tooling instructions.

→ The simulation capabilities of digital manufacturing helps reduce comissioning costs by validating robotics and automation programs virtually.

→ Using DM, one can create factory models faster and

ensure that they are operating under optimal layout, ③
material flow and throughput before production ramp-up.

-> DM can be used to support six sigma and lean manufacturing initiatives, by providing graphical environment to analyze dimensional variation.

-> DM process facilitates sharing quality data across ~~your~~ the organisation by generating complete, verifiable CAD-based machine inspection programs for co-ordinate measuring machines and numerical control machine tools.

-> DM allows to execute production processes with real time access to lifecycle data.

-> DM reduces need for physical prototypes and mockup.

-> DM provides ~~clea~~ clear insight about the space, time and investment required throughout the product life cycle.

-> Digital manufacturing offers support evaluating the efficiency of the production line in order to optimise and balance the work across the work stations.

3] Manufacturing the first one

Manufacturing the first product is the first stage of the manufacturing process. Since it is on the engineering manufacturing border, it is fuzzy where engineering leaves off and manufacturing begins.

At this intersection, the manufacturing of the first product is the large potential source of wasted time, energy and material. as the product as-designed is reconciled with the product as built.

-> The manufacturing function is completely responsible for defining the processes that actually manufactures the product.

-> If the digital substructure of PLM is available, then DM can tap into it in a varaity of different areas to replace time, energy and ~~information with~~ material with information.

-> DM can use virtual space to eliminate wasting valuable real resources.

-> It can the save on the resources that can never be recaptured like time

-> DM can be applied at this stage for the following activities.

i) process planning and Reuse
ii) Machine, Tool and future development of process
iii) Robotics and PLC simulation and programming
iv) Ergonomics
v) Factory flow simulation.

i) <u>process planning and reuse</u>

DM provides value in this area in atleast two ways.

-> First, process engineers can use the math-~~cad~~ based CAD descriptions of the product and the machines to determine if the process is feasible. Such as
* DM can determine if the tooling is capable of

performing the required operation.

* DM can echeck for collisions of the machine and tooling in the product being operated on.

Rather than specifying operations that theoritically work, process engineers can validate the operations they are specifying with the exact product and exact machine, tools and fixtures that are to perform those operations, in digital form.

-> Second, the use of DM integrates the process planning from design and engineering into the manufac-turing area and makes manufacturing a partner in the process, rather than a recipient of the outcomes of the design stage. By integrating Design and engg. with manufacturing process, changes that manufacturing engineering makes to the processes will be fed back to design and engg. function.

-> The next logical action is to reconcile manufacturing's changes with the design team's proposed process. This will lead to better understanding b/w design and manufacturing team and also lead to recover wasted time energy and material by making use of reusable processes [Reusable processes are the manufacturing equivalent of reusable parts in the design & engg. functions]

-> With reusable processes that have be reconciled ~~with~~ between design and engg function & manufacturing function, the product development process can begin with a search of a library of processes rather than simply building processes from scratch.

→ With proper categorisation and search system, design and engineering planners can produce process plans in a fraction of time that will be acceptable to the manufacturing group.

→ DM makes all the above possible by connecting manufacturing into the PLM information substructure and facilitating the exchange and reconcilation of processes.

⇒ ii) <u>Machine, Tool and Future development and process</u>

One of the time-consuming aspects of manufacturing the first product is determining exactly how the product must be processed by specific machines and tools.

There are two cases in this

* The first case is when the machines and tools are given
* The second case is when the machine and tools are to be designed and built as part of the manufacturing process.

In number of cases the first case may be easier to deal with, given that the constraints are imposed by virtue of the existing machines, tools and fixtures.

* The part are product specification is given
* The machine, tool & fixture specifications are given
* The task is to take above constraints and determine a permutation & combination of operations that will yield the specified part in most economical way.
* Human beings are not equipped ~~with~~ to do an exhaustive search of all possible combinations (or) permutations.

* Computers are under no such limitations. Using DM, all possible combinations of operations can be tried.

The second case of producing product when, machine tools, fixtures are not given and are also to be built ~~for~~ a is simpler in one way and more complicated in other.

* The simpler aspect is that by designing the machines, tools and fixtures we can be assured that component (or) product can be produced - at least theoritically.

* The more complicated aspect is designing the machines, tools, and fixtures is as challenging than designing the product itself.

* The move to DM saves substantial amounts of wasted time, energy and material. by adopting concurrent engg. technique in designing m/c tools & fixtures in a virtual space.

iii) Robotics and PLC simulation and programming

Robotics and equipment controlled by programmable logic controllers (PLCs) perform their operations under the control of a computer rather than a human operator.

Without DM, robotics and PLC-controlled equipment are subjected to shake out & testing. programmers write programs to perform the operations required to produce the product.

The programmers must then run their programs to debug them, as the programs never do what the programmers think they are going to do.

Using DM, virtual equivalents of physical machinery are built in the virtual ~~to~~ world. Their operations are simulated and the math based designs are modified until the required performance is obtained.

Only when the simulations produce the desired results in virtual world they are adopted in actual machinery (or) equipment.

The scrap produced by testing and debugging is all virtual.

Ex: Use of simulation softwares in checking part programs written for CNC Turning and milling machines.

IV) Ergonomics

-> The human worker is and will be an integral part of the modern factory. DM must incorporate human ergonomics and factors in order to be able to accurately and completely simulate factory production

-> If a task requires the wrist of operating personnel to be bent at an angle that is incompatible with human structure, then the task can be redesigned.

-> DM can rapidly perform analysis of different operations to determine which combination of potentially feasible human operations minimize waste.

-> Ergonomic analysis has to determine not only whether the operation is feasible for a range of human sizes. It must also be consistent with safe standards that allow human beings to perform that operation over and over again with lowest risk of injury.

-> DM's use of simulated activity, while implementing healthy practices, ensures that operations are efficient and safe for a wide range of human workers.

v) Factory flow simulation

-> The next unit of analysis in the quest is the factory itself. Machines, tools, robotics, PLC controlled equipments, and human beings all come together on the factory floor.

-> While individual operations ~~are~~ can be designed, analysed and continually improved, but how these operations are sequenced has a huge impact on the overall efficiency of the production system

-> The goal is not to perform individual operations optimally, It is to perform entire production cycle optimally.

-> Previous factory flow simulation methods used probabilistic methods to predict flow performance at the factory, this was useful in predicting through put and bottle necks.

-> Today, the factory of the future will be fully specified, simulated and optimise before the ground breaking. Not only can the entire factory be visualised and simulated production runs performed, but individual areas can be zoomed into & the performance of individual cells or equipment can be analysed.

4 Ramp up (or) Ramping production up

Ramp up is the term used in economics and business to describe an increase in firm production ahead of anticipated increase in demand. Alternatively, ramp up describes the period between product development, and maximum capacity utilization, characterised by product and process experimentation and improvements.

As ramp up is typical in early stages of firm or market development, the ~~term~~ term and process is widely associated with Venture capital.

A ramp up typically occurs in anticipation of an imminent increase in demand. While it is a feature of smaller companies at an early stage of development.

A ramp up can also be taken up by larger companies that are rolling out new products or expanding in new geographies.

Ramp up also entails substantial outlays of capital expenditures and human ~~res~~ resource expenses. For this reason, a ~~compoanly~~ company will generally only consider a ramp up once it has a reasonable degree of certainty about additional demand. Otherwise, if the anticipated demand does not materialize or is below projected levels, the company will be saddled with excess inventory and surplus capacity.

The main goal of the digital manufacturing is to eliminate this stage of production process in real space. This is an idealistic goal because of the accuracy of the virtual space is such that there will always be gaps between the simulation in the virtual space and what actually happens in the real space.

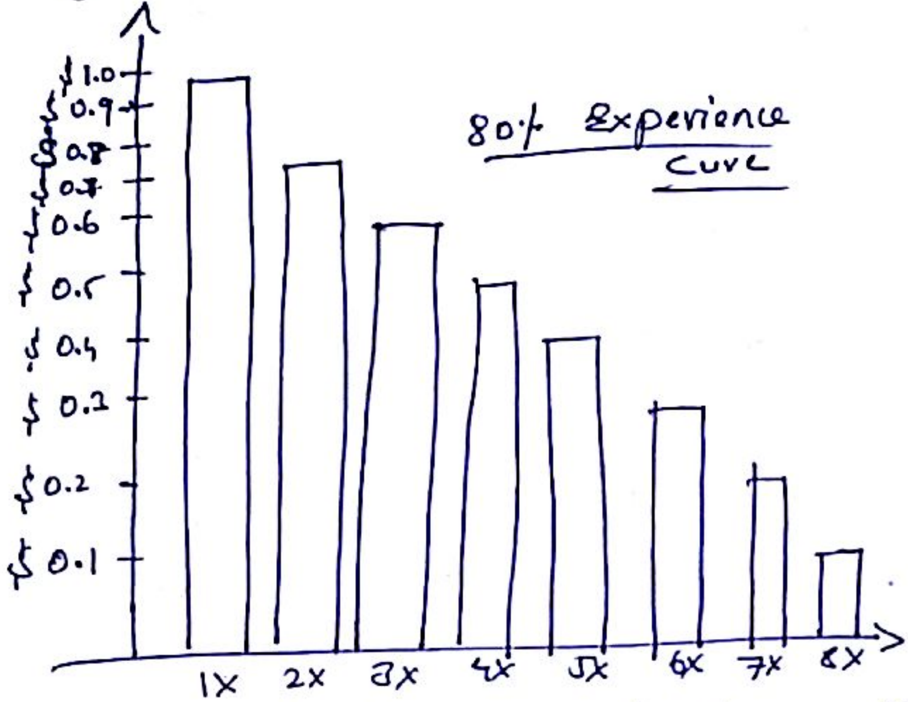
In spite of above limitations DM has the promise of greatly reducing the ramp-up time of the product manufacturing through simulations.

Thus the DM has the potential to reduce a substantial amount of wasted time, energy, material, incurred during the ramp up process.

5) Virtual Learning Curve [Learning and experience curves]

The virtual learning curve represents, the amount of wasted time, energy and material ~~w~~ with respect to the cost which is superimposed. Experience shows that the production costs decreases as the number of units produced is increased, because the cost involved in repeated tasks, ineffecient process planning reduces as we gain experience. ⑦

The following figure is an example of an 80% learning curve.



For every doubling of production units (1X, 2X, 3X etc), costs decrease by 20%.

Above is the pattern of learning or experience curve that is normally thought to occur naturally in organisations.

What DM strives to do is save the cost wasted during the ramp-up process by starting the virtual production at the top of the experience or learning curve and only starting physical production when the learning curves begins to bottom out.

The ability to actually do this depends on ~~variety~~ variety of factors

→ For production processes that are highly automated with production operations that are well defined and suitable for simulation, the potential to drive down the experience or learning curve virtually is high. Once the simulation shows the required result, the instruction to produce them can be downloaded into the computers controlling the actual equipment.

→ For those processes that have substantial amount of human interaction, the potential for eliminating the cost of ramp up will be less. While the factors external to human participants can be improved (e.g. reducing steps necessary to retrieve material, rearranging the sequence of actions to eliminate wasted motion), the actual actions of the human beings have to be learned and improved through repetition.

6) Engineering change orders [ECOs] and Implementation

The challenge of ramp up is more than simply driving down the experience or learning curve. Manufacturing ramp up of new products is invariably ~~com~~ accompanied by product changes, commonly referred to as ECOs.

ECOs occurs for a variety of reasons.

→ Sometimes the issue is that the product does not have all the functionality that designers and engineers envisioned.

→ There may be unintended functionality that was not anticipated.

→ There may be issues with suppliers that mandate the replacement of one component with another that requires different operations and processes.

PLM as an entire approach in general and DM specifically should reduce the amount of ECOs - companies utilizing PLM have reported an astounding 65% reduction in ECOs

DM, by providing better co-ordination, communication and simulation in the first stage of manufacturing

R, will further reduces the need for ECOs.

Problems with supplier components, operations, and even product functionality can be surfaced and corrected without these problems ever making it to the manufacturing floor.

Finally, for the ECOs that are unavoidable, DM can reduce the disruption of introducing the ECOs in to the manufacturing processes.

-> The ECO introduction can be simulated to determine the least ~~dist~~ disruptive method for installation.

-> Automated equipment can be reprogrammed and debugged in virtual space.

-> New work instructions can be designed and workers trained off line.

-> Only when the issues surrounding the ECOs have been fully worked out virtually will they be moved to the factory floor.

[**Note:** If the question is asked to write a note on Ramp up, it should include section 4, 5, 6.]

7] Manufacturing the Rest

While DM plays a critical role in manufacturing the first product and attempts to eliminate manufac- -turing ramp up, it needs to continue to play an instrumental role in manufacturing the rest of the product.

DM applications are the source of information that can be used to replace wasted time, energy, and material as products continue to flow through the factory. DM has the information on how the products should be manufactured, DM can use the same information to compare against the actual production of products and to capture information about the actual production for use in other stages of the product's lifecycle.

Areas that DM can play a part in are
-> Planning the production in the factories.
-> Assisting in the actual production by providing production information as required
-> Monitoring and auditing the production process against the specifications.
-> capturing exactly how the product was built (for future use).

8) Production Planning

Production planning is an important tool for manufacturing and engineering, where it can have a major impact on the productivity of a process.

In manufacturing, the process of production planning is to minimize the production time and costs, by telling a production facility when to make, with which staff, and on which equipment.

production planning aims to maximize the efficiency of the ~~product~~ operation and reduce cost.

The digital production planning tools greatly outperform older manual scheduling methods. These provide the production scheduler with powerful graphical interfaces which can be used to visually optimise real-time workloads in various stages of production, and pattern recognition allows the software to automatically create scheduling opportunities which might not be apparent without this view into the data.

For example, an airline might wish to minimize the number of airport gates required for it's aircraft, in order to reduce costs. The scheduling softwares can allow the planners to see how this can be done, by analysing time tables, aircraft usage, or the flow of passengers.

Companies use Forward and Backward scheduling/planning methods to allocate plant and machinery resources, plan human resources, plan production processes and purchase materials.

Forward scheduling is planning the tasks from the date resources become available to determine the shipping date or the due date.

Backward scheduling is planning the tasks from the due date (or) required-by-date to determine the start date and/or any changes in capacity required.

Functions, need (or) Objectives of production planning

a) Effective utilization of resources: production planning results in effective utilization of resources, plant capacity and equipments. This results in low-cost and high returns for the organisations.

b) Steady flow of production: Optimum allocations of machines and operators results in continuous, steady flow of production focused on meeting customer demands.

c) Estimate resources: production planning helps in prior estimation of resources required for the production such as man, machine, voltage, Raw material Etc.

d) Ensures optimum inventory: production planning ensures Over-stocking or under-stocking of inventory. Always necessary stocks are maintained corresponding to the product demand. Stocks of finished goods also optimised.

e) Co-ordinates activities of departments: Production planning co-ordinates with other department to make planning efficiently. For example production planning maintains a good relationship with sales department to know the scenario of product demand, It co-ordinates with purchase department to know the inventory levels. It co-ordinates with maintenance department to know the condition and availability of machines.

f) Minimise wastage of Raw materials: Production planning ensures proper inventory of raw materials and material handling. It also ensures better quality of products and hence reducing wastage of Raw materials.

g) Improves Labour productivity: Production planning improves labour productivity. Here, there is maximum utilization of man power. Training is provided to the workers and profits are shared with workers in the form of incentives and increased wages. This motivates the labour to give or perform his best.

h) Helps to capture the market: production planning helps to delivery give delivery of products to customer in time. So the company can face the competition effectively.

i) provides better work environment

production planning provides better work environment to the workers. Efficient production planning facilitates in providing leaves, holidays ~~on~~; increased wages and incentives and effective reallocation of workers etc.

j) Facilitates quality improvement

Continuous monitoring of production flow for errors leads to improvement of quality of product since all the errors and mistakes are cleared as soon as they arise. Quality conciousness is developed among the employees.

k) Results in consumer satisfaction

l) Reduces production costs by optimum utilization of resources and optimumizing inventory.

~~Benefits of production planning~~

→ ~~Process change over~~ reduction

→ ?

Note: same answer for Benefits of production planning.

—————— THE END ——————

PRODUCT LIFE CYCLE MANAGEMENT

UNIT-8 : Developing a PLM Strategy and Conducting a PLM Assessment.

Strategy and impact of strategy, implementing a PLM strategy, PLM initiatives to support corporate objectives, Infrastructure assessment, assessment of current systems and applications.

1] **Strategy** : " A strategy describes : the way to achieve objectives; how resources will be organised; managed and used ; policies governing use and management of resources."

"A strategy is high level plan to achieve the goals under the condition of uncertainty.".

The common usage of strategic plan refers not only to the actual plan to accomplish goals and objectives, but the goals and objective themselves and also the analysis that goes into assessing the organisation's and environment's suitability for such goals and objectives.

The elements of a strategic plan

* A vision of the future
* A realistic assessment of where we are today
* A plan of action for bridging the gap b/w the reality of today and the vision of tomorrow
* The capabilities and resources necessary to carry out the plan.

A vision of Tomorrow

-> If there is no perception of what we think tomorrow will look like, then there really is no need to produce a strategic plan.

-> Without a vision of tomorrow inertia takes over and whatever we are doing today, we will keep doing tomorrow.

-> Some companies feel successful even without a vision for tomorrow, but when conditions change these organisations find themselves unhappy with the results because they did not have a vision of tomorrow.

-> Visions of tomorrow for organisations almost always include the organisation's being more profitable and larger.

-> Because of it's impact across the entire organisation, PLM is a logical part of a strategy to increase revenues and reduce costs. The resources freed up can drive an increase in product variety, quantity, functionality and quality.

A realistic assessment of today

-> If we do not know where we are, it will be difficult to go where we want to go.

-> If we are unrealistic or even delusional about our current situation and capabilities then we will be starting toward our vision of tomorrow from a faulty starting point.

-> The realistic assessment of today involves assessment of our surrounding environment. The environment includes customers, competitors and governments.
-> we need to assess each of the above in order to understand how we obtain our vision of tomorrow.
-> These assessment can be easily done using PLM information core otherwise which would have been difficult.

Plan for bridging the gap

-> This has to include three aspects - people, processes and practices and technology. All three of these elements have to come together in a co-ordinated plan for an organisation to get from where it is today to where it's vision is for tomorrow.
-> If ~~no~~ one of these elements ~~of~~ is not addressed, the whole plan suffers.
For example, If the right software is aquired ~~and~~ but people are not trained to use that software, then people cannot use the software at all.

Capabilities and Resources required

-> While an organisation may have an excellent vision of what tomorrow should look like, a great assessment of their internal capabilities, and a realistic view of what their competitors, customers and government are doing. If they don't have the resources and capabilities to carry out the plan, there is little possibility of their realizing their vision of the future.

→ For all organisations, there is only a finite amount of resources, and those resources are allocated on the basis of their perceived value of return to the organisation.

→ PLM, with it's ability in freeing up resources by identifying areas where resources are getting wasted helps in ~~red~~ re-routing of resources in right way ~~at~~ to achieve the vision of tomorrow.

→ But, once the resources are provided, a strong Leadership is ~~requisite~~ required which is a key capability in executing the plan and making the vision of future more a reality.

→ Along with the right leadership strong management and communication with the people involved is must in avoiding our vision end up as a day dream.

2] Implementing a PLM strategy

To achieve the PLM vision two strategies need to be developed. These are PLM strategy and implementation strategy. The PLM strategy shows how PLM resources will be organised in the future, envisioned environment.

The implementation strategy is the starting point for developing and implementing the implementa-tion plan. The implementation strategy shows how the resources will be organised to achieve the change from today's environment to the future environment.

It is best to develop the PLM implementation strategy when both the current situation and the future situation have been defined. The implentation strategy is sometimes referred to as a change strategy or a ~~Develop~~ Deployment strategy

Before starting to develop an Implementation strategy, it's useful to recap what's available. There should be a lot of ~~foud~~ foundation information available including objectives, targets, a PLM vision, a PLM strategy, a description of the current situation, and a description of the future situation. It's on the basis of these that the implementation strategy will be developed.

Implementing a PLM strategy have five general steps to be followed.

i) Collecting the information.

A very good understanding of the activities and information about the product life cycle is needed to develop a PLM strategy. The understanding must be based on the facts and not on the assumptions. The information is collected based on the current situation.

The current situation can be
-> objectives of PLM -> User requirements
-> product development -> Methods of creating, communicating and storing the product data.
-> Organizing the activities of life cycle.

Since there is so much of information available it's important to define / understand the current situation. In order to find the current situation following questions have to be answered.

-> what is the real business objectives. ?
-> what are the customer requirements ?
-> Is competition price of the product is sensitive ?
-> what is the demand (present) for product in market ?

With different techniques such as brainstorming, process analysis and uses of questionnaires wherever appropriate the necessary information required about the product is collected.

ii) Identifying the possible strategies

In the second ~~set~~ step of strategy ~~devlo~~ development several potential strategies are identified, formulated and described in terms of the organisations and policies to be applied to the resources.

It is always useful to identify and describe several possible strategies. This will improve the chances of finding the best alternative strategy as most obvious ~~strategy~~ strategies need not be the most appropriate strategy.

iii) strategy selection and analysis of selected strategy

A set of PLM strategies chosen for PLM has to meet the objectives of the company, as each company will have a different objective has well as different resources and different environment.

The strategy that a company develops will be different in some respect from that of any other company. However it is important that the PLM strategy to be very simple and clear.

Once the strategies are developed their potentiality has to be tested and most appropriate strategy is selected and detailed. It is useful to investigate between 3 or 4 alternative strategies, which will lead to an in depth understanding of the possible strategies. The strength and weaknesses of a particular strategy often becomes clear when examining the strength and weakness of other strategies

The analysis of different strategies is often called as SWOT analysis. The acronym SWOT stands for strength and weaknesses, opportunities and threats.

IV> communicating the selected strategy

In this step the chosen strategy is communicated to the people who will be affected or involved. Communication of the strategy is essential. A strategy becomes useless, unless the people are fully involved in it.

Before broadcasting a strategy it has to be tested with few people who are typical audience. If they dont understand it, then one has to make sure that it is understood before communicating more widely. The more the people understand the strategy, the more chance it has being imple-mented.

v) Implementation of selected strategy

In this step the communicated strategy is again assessed with respect to financial strength of the organisation.

If the organisation is willing to implement this strategy then a proper plan or framework has to be prepared so that during the implementation of selected strategy it is easier for managers and others will have link to all the issues.

3 PLM initiatives to support corporate objectives

-> The first and foremost objectives of any organi-sation is to increase it's revenues and reduce the costs.

-> The drivers of revenue growth are increasing functionality, quality and quantity of products sold. Additional resources are required to achieve above qualities. PLM applications etc. enable areas or departments to free up the needed resources by utilizing existing resources more efficiently.

-> To reduce the costs, better visibility and control of product information allows the reduction of materials used and time consumed. PLM applications that track and control math-based designs allow departments to avoid wasting time working with old and outdated versions.

The following are the key initiatives to achieve corporate objectives
i) See beyond functional barriers.
ii) Watch for optimal decisions that are suboptimal.
iii) Think ONE Organisation.

i) See beyond functional barriers

-> It is easy in the face of resource constraints to take actions that benefit our own area to the detriment of another area.
-> An effective PLM strategy will require a larger view and while there may be short term benefits in a narrow view, eventually the organisation will be less competitive than organisations that do have a PLM view.
-> It is far better to try and develop this larger view of product information sooner rather than later.
-> We can develop this view even if do it informally by establishing ties to areas that are adjacent to ours, such as engineering to manufacturing (or) manufacturing to service.
-> These are areas that develop information that we use or that we develop information for. If we dont have ~~to~~ authority to establish cross-functional teams, we can develop informal communications & consultations with those areas.

→ In many ~~situati~~ situations like above PLM can serve as a common focus ~~on~~ to co-ordinate & consolidate product information that all these sub-specialities can share and use in one place.

ii) Watch for optimal decisions that are suboptimal

→ When the pressure is on to reduce resources, the first choice for elimination are resources that support cross-functional information flow.

→ It is easy for the engineering department to give up resources that support process development needed by manufacturing, or for service and support to eliminate resources to capture and analyse warranty information that could be used by engineering to reduce defects and improve the product.

→ We can ~~easily~~ usually try to optimise the use of resources in an area even if that optimization causes a suboptimal use of resources across the entire organisation.

→ The problem is that these are easy decisions to make and making these resource decisions improves our own area and the negative impact to us from other area is negligible by making these decisions.

→ Managers of the areas who faces such situation should resist such opportunity because these easy decisions go against the spirit and practice of PLM

→ Instead they should look for resource usage that is wasteful and only affects their area. In order to provide some visibility for these issues, managers should enlist their counterparts in the organisation

Who will be impacted by the loss of information from potential resources cuts in analysing the overall organisational effect.

iii) Think ONE Organisation

-> Since PLM is an approach, one of the most important things any employee can do is to act like a CEO to embrace the One Organisation theme.

-> Making decisions about how people deal with product information within a certain functional area, what processes and practices are employed, and what technologies are aquired to support these activities without taking into consideration the entire organisation is counter productive.

-> Sometimes, getting good enough is better for organisation than a misguided attempt at ruthless optimisation.

-> It is not enough for the CEOs to point the One company vision. Everyone is responsible for using that ~~decisions~~ vision to guide their decisions.

-> CEO's do not have the detailed knowledge about the product information to make proper decisions but managers and employees do.

-> Everyone is capable of internalizing the vision of One company as they ask themselves what is the best way for their organisation to get the most value out of product information.

-> PLM has the most impact for the organisation if it is a corporate initiative defined by a comprehensive strategic plan that supports goals and objectives of the entire organisation.

→ However, if PLM currently does not have this level of visibility and commitment, the alternative is not to abandon any effort to engage in PLM initiatives that are more limited in scale and scope. PLM can be bubbled up from within the organisation. With success comes increased visibility.

4] Infrastructure Assessment

PLM is not simply an application which can be used as is. There are issues of culture, process, practice and even power that will affect the success of PLM within the organisation.

Assessing an organisation's readiness for PLM requires an assessment of all the elements of PLM - technology. Not only of the enabling PLM technology, but it's infrastructure, people and their processes and practices.

This assessment needs to done using a systematic and understandable framework that compares where we are with and where we determine we need to be.

Infrastructure assessment involves,

i) computer/communications infrastructure
ii) Adequateness of the current technology
iii) Scalability of the technology
iv) Modularity of the technology
v) Openness of the technology.

i) Computer/communication (C/CI)

The PLM software applications require C/CI on which to run. The PLM software applications are not trivial in their infrastructure requirem-ents, so a careful assessment of the C/CI is an important aspect of any readiness assessment.

Having excess capacity w.r.t C/CI does not add anything to the PLM initiative. However, having less capacity than required can cause the PLM initiative to flounder and possibly fail.

As a general statement users are comfortable with the computer applications they currently use, they reluctantly use new applications.

More disruptive to the PLM initiative, users will circumvent, or bypass the system by minimizing their use of the application.

W.r.t C/CI there are four things that needs to be looked at. They are explained in following sections.

ii) Adequateness of the current technology

With respect to adequateness, we need to assess the components of C/CI to see that they are adequate for the current applications that are being deployed to them. We also need to assess and evaluate the new requirements that these PLM applications will place on the infrastructure.

The three major component areas that need to be assessed are computing ability, bandwidth capability and storage capability.

Computing ability : The two aspects of computing ability are w.r.t individual users and centralised applications and databases. A careful assessment of people affected by PLM initiative, an inventory of the computer systems they use, and an analysis of the new requirements placed on those computers need to be undertaken.

Storage Capability : On the server and database side, the requirements for people to access the central repository of models and math-based drawings will put substantial pressure on the resources of those systems to respond. Hence a careful assessment need to be done to identify the current position and future needs in these are so as to be on par with increasing scale of Organisation.

Bandwidth Capability : The bandwidth issue needs to be assessed carefully inside individual areas of the organisation, in different geographical locations within the organisation, and outside of the organisation. Moving math-based drawings currently takes a tremendous amount of bandwidth. If the access is allowed to a wide ~~variety~~ variety of people who currently do not have this ability, the requirements for bandwidth increases substantially. In addition, transfers of math-based information b/w geographically dispersed locations will also increase.

iii) Scalability of the technology

Special care must be taken to look at the upper limits of computing, storage and bandwidth, and determine whether there is any point at which the system will become fully saturated and unable to scale. That point must be assessed fairly carefully because, if it is not, the infrastructure will build to that particular point and then degrade rapidly, putting the entire system in jeopardy.

iv) Modularity of the technology

Modularity is important because it makes sense to add capacity in small quantities or increments. With the computing power of today, the cost to add a new increment of computing capability or storage is generally not that great, and therefore that decision is made fairly easily.

The network backbone is generally the constraining factor for bandwidth and increasing it's capacity is usually an expensive proposition.

v) Openness of the technology

Openness is extremely important for PLM, since the scope of PLM is so vast No one solution provider will be able to perform all of the functions that are required in an organisation for full PLM implementation.

Open architecture on both the hardware and software side are a must so that technologies & applications can work together to provide the functionality that the customers require.

5] Assessment of current systems and applications

It's important to assess the current system and applications that are within the organisation. Generally the information technology groups have their information as they are responsible for installing, maintaining, supporting these type of system.

Generally the information are well documented in the organisation, where the map of information flows from system to system on an ad-hoc basis so that information could be readily made available for the analysis as and when required by the user.

-> In any case the purpose of this current assessment system is not ~~simple~~ simply to assess the formal systems that are in place within the organisation and are well defined, but to get to the underlying informal systems/practices that exists within the organisation.

-> There are 2 reasons for this, the first is to make sure that any new system will incorporate these information flows within it. The second is to get the opportunity to assess these information flows and see if the informal practices that has been built up over the years are defined as the processes.

-> The problem with this assessment is that they are undocumented and not formally known to the organisation so that if the people who are capturing, maintaining and processing on this information when replaced (or) retired then that information is suddenly lost, the well functioning operation that ~~are~~

have been existed up to that point in time are (4)
suddenly disrupted and no one may know the reason for disruption.

Example: In a paint department of major manufacturing firm, a long time used to monitor the makeup of the paint and the ~~vo~~ weather condition of the plant. Whenever the temperature was dipping below the certain point then the employee would add up preservative chemical to the paint to prevent the batches of paint from freezing. When this employee got retired the batches of paint that are reproduced in the winter suddenly froze and no one can make out the reason for it, until the management investigated and spoke to the employees who had worked with this retired employee that the retired employee was performing the additional process informally.

Applications

i) people assessment

With respect to product information, one of the first assessment opportunities is to determine the amount of time that has been spent on unproductive tasks. What an organisation needs to identify is ~~to~~ how much time it's people spend on, searching, duplicating, re-creating, copying, distributing and simply wasting information.

The amount of time that people waste in above mentioned unproductive tasks can be assessed through surveys, interviews and observations.

The next aspect that needs to be assessed is the magnitude, ability, willingness, timing and distraction of the people involved in adopting a new system.

Magnitude: People can handle smaller magnitude changes better than they can handle large magnitude changes. The magnitude of change needs to be considered for transition period in learning a new system.

Ability: The assessment that needs to be made is the ability of the people to handle the newly introduced IT applications, and this assessment requires understanding the amount of training and education that needs to be given.

Willingness: The willingness of people to make changes can be a major stumbling block. The willingness is involved not only with the actual implementation of the PLM system, but also may be a factor in the assessment.

Timing: With respect to the assessment, on also needs to look at the issue of timing at which the change should be brought in the implementation of new systems.

Distraction: Finally we need to assess the elements of distraction. Distractions are those events within the organisation that may detract from the attention level of the people who are responsible for these new changes. If the level of distraction is high, we need to make an assessment and understand that assessment before (or) prior to trying to implement a new system.

ii) Process/Practice Assessment

An assessment of processes and practices needs to be undertaken in order to understand exactly what information is needed and used within an organisation.

The following aspects are considered in doing process/practic assessment.

Processes : With respect to process assessment, the requirement is to verify the completeness of process maps, evaluate gateway placement and map paper to digital process. Every day processes are adapted and modified to fit the needs of new requirements that have developed. As a result if process maps are ~~an~~ not reviewed for a while, they can be hopelessly out of date. It is good to update process maps on regular basis.

Gateways : Decisions about evaluating and approving product milestones require that there are gateways for this product to get through in order to maintain the viability of the product process. In some cases, the gateway's approvals are after the fact formalities. An assessment of gateway placement needs to ensure that these gating events are real, operational events and not formalities, either before (or) after the facts.

Mapping process maps to digital processes :

Assessment need to be made & about mapping paper to digital processes. In many organisations, paper is a very comfortable thing to move around from person to person, & simply holding paper as one would a token becomes part of the imbedded processes within an organisation. Removing that piece of paper changes the dynamics of how people work. As a result, before that paper is replaced, the digital process that ~~needs to be~~ is going to replace it needs to be identified and understood.

<u>Practices</u>: While the processes are fairly straight forword, practices generally are not. The three elements of assessment are → To develop interface maps
→ To map information streams and wells locations
→ To identify rote practices.

Developing interface maps means understanding who interfaces with whom in the organisations. It will help to identify the informal systems practiced in organisation and to replace them with formal systems. We also need to identify the rote practices. These are practices that began as practices because people were unsure of how to link inputs to outputs. They are now understood well enough to be formalized in a process.

<u>Information streams and wells</u>: We also need to map the Information streams and wells. Streams are the flow of information within the organisation on both a formal and informal basis. Wells are those repositories of information that exist to provide information ~~systems are insufficient for their particular~~ ~~jobs~~. that may be more difficult to obtain or is not readily available.

iii) Capability Maturity Model (CMM) Assessment

Once we have identified the areas we need to assess, it is important that we establish an assessment framework. One that appears to have gained acceptance in the IT area and has been used by solutions providers in their assessments is CMM. CMM has five levels.

- → Initial (adhoc)
- → Repeatable
- → Defined
- → Managed
- → Optimised.

Initial: At the initial level, all the work in an organisation is done on an adhoc basis. For these organisations every day is a brand new day. There are very ~~p~~ few processes in place, or at least these processes are not repeatable ~~and~~ or definable

Repeatable: The second CMM is repeatable processes and practices. At this stage, the organisation tends at least to do the same things in the same way given the same specific inputs and the desired outputs. It is output-efficiency based, meaning that it appears to work, so therefore people tend to do the same thing over and over again.

Defined: The third CMM level consists of defining these processes and practices. We ~~have~~ now have enough information about them to define what the inputs are, what the desired results or outputs are, and what processes ~~to~~ & and practices are needed to link inputs and outputs.

We can document this so that we can compare this situation to future situations to ensure that it is repeatable.

More ~~import~~ importantly we can institutionalize these processes and practices so that new people coming into the organisation can understand what needs to be done in a much shorter period of time.

Managed : The fourth CMM level is to manage these processes and practices. We analyse the processes and practices and develop methodologies to determine the amount of resources the processes consumes and the results (or) outputs we obtain. We develop specific goals for the resource consumption and output quality and quantity. Again we have to measure each time we perform the processes and practices to see how we do against our goals and objectives.

Optimised : The fifth CMM level is to optimise the processes and practices. Apart from measuring and evaluating the processes and practices against our goals & objectives we have to look at continually improve the processes and practices so that our goals and objectives increase.

Above will help in assessing the systems, processes and practices we have in place & make sure that we are changing the organisation prior to the occurance of a change rather than reacting to them after they occur.

THE END