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Product building and structures – an overview

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Abstract: Technological development became the aid of new discoveries in each and every field of the world. Product building and structures is considered the soul of products and marketing system. From conventionally manufactured products to the virtual product development is also the case of technological enhancement in case of saving money and time and also increasing the production. Virtual product development have the large number of benefits upon the conventional product development. The most important tools or models of virtual product development in 3D CAD system and digital mock-up comprises the components like virtual product simulation, virtual product staging and digital manufacturing. 3D CAD system and digital mock-up becomes the actual channel in product building and structures.

Keywords: Virtual product development, 3D CAD System, Digital Mock-Up

1. INTRODUCTION

Conventionally manufactured products waste a lot of time and money to build a prototype of a product and the manufacturing process to be used prior to the actual manufacturing process starts. In order to optimize product design in the best way, the time spent in traditional processes must be used effectively. In modern times, product competition on the market is growing rapidly. Traditional methods bring good luck to the company. This is the moment when virtual product development is born.

2. VIRTUAL PRODUCT DEVELOPMENT

Companies which are involved to build a product focuses on minimising the production or manufacturing cost beside with the increasing productivity, quality etc. Due to market competition, customer needs, new technologies, market trends, etc., it becomes difficult to develop new products. In order to improve product development and reduce complexity, a new approach is being sought that represents a shift from traditional to Virtual Product Development (VPD). Virtual product development eliminates the design problem and gives a better understanding about attributes of productive performance. In the virtual product development, prototypes are being made virtually and the problems are detected early these problems can be solved before the actual development of product. Reducing time and money results the cost effective designs provides reliability in less time than the conventional process. Product development refers to the modelling of a product to virtually meaning is virtual prototyping with the use of advanced computer technology. Here we can understand the virtual product is a digital representation of a product created in computers. Virtual product can be of 3D or 2D models beside with the required information for actual manufacturing of product. Definition: Virtual product development refers to the working and analysis techniques, processes and methods for product development in a virtual environment, which is created using advanced computer technology.

Benefits of VPD are given as follows:
1. As we are not building any physical prototype it helps us to reduce the cost and time.
2. It helps us in evaluating the concept of design and test the product multiple times, without actually build the product.
3. With the help of virtual product development we can perform any task as in the development cycle.
4. Final product will be optimised and will be based on customer needs and wants
5. Manufacturing virtual product development helps us to provide information about potential safety issues
6. Product will be developed fast which in turn helps in the fast delivery of product in the market, in fact that it would lead the market competition.

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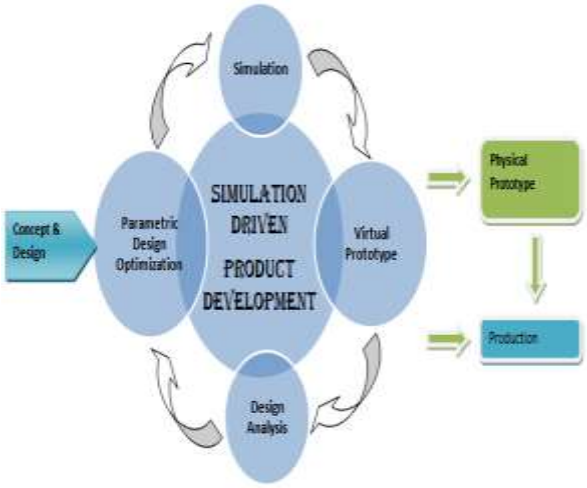

Fig. 1. Virtual Product Development

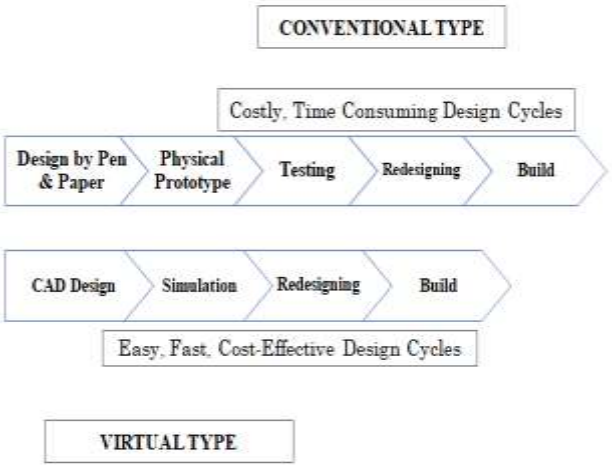

Fig. 2. Steps involved in conventional and virtual product development

3. VIRTUAL PRODUCT DEVELOPMENT TOOLS (MODELS)

Virtual product development is the process of making and prototyping products in a digital 3d/2d environment.
Virtual product development consists of four main components:

1. Virtual product design 2D shape 3D graphics
2. Virtual product simulation
3. Virtual products staging

4. COMMON TOOLS

4.1 3D CAD systems (software)

Traditional or conventional way of designing a product was limited to the 2D drawing with the pen and paper. The product designers was not able to make 3D models. By the use of 3D CAD software, the product developers or designers are able to create the product in 3D model along with that the testing of the model can be done. Mostly used 3D CAD Software are Solidwork, Solid edge, Unigraphics, NX, Catia, etc. In the software system the model can be saved in different formats. Which can be used to exchange the models to different softwares. 3D CAD softwares provide the actual features to the model as of the actual product.

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4.1.1 Benefits of 3D CAD software systems

4.1.1.1 Time saving

The time which is used to produce or manufactured the product and 2 test on it in conventional way of manufacturing is saved by use of CAD system.

4.1.1.2 Increases productivity

The productivity will be increased by the use of saved time. the higher number of projects can be completed by the same time or we can say that the more number of products can be manufactured.

4.1.1.3 Improve accuracy

Use of 3D CAD system is advantageous than the manual designing. There can be a lot of mistakes or errors in a manual design. CAD design are error-free that led to the higher accuracy.

4.1.1.4 Complex shapes

Complex shapes can be produced with CAD systems. However it is difficult to produce a the complex design manually. And also perfect results are obtained by cad system tools.

4.1.1.5 Decreases error

Unique advantage of CAD systems for 3D model provides interference checking feature. This feature helps the designer check for interferences between one or more parts.

4.1.1.6 Improved quality

The quality of the product is improved as cad system produce the product as error free, with high accuracy etc.

4.1.1.7 Easily understandable

3D models in CAD software are simple to understand rather than in the manual drawings. At least 3 sketches are required to get the idea of the product in manual drawings (plan, elevation , and side view).

4.1.1.8 Quick Shearing

The model of product will be saved in different formats so that it can be shared to different softwares. Sharing is instantaneous.

4.2 Digital Mock-Up (DMU)

Digital Mock-up is our overall product evaluation of 3D development and maintenance. The DMU contains all the information about the product geometry and configuration. The DMU process is used for packaging research, accident detection, assembly and assembly simulation, and other 3D CAD-based analysis. For example, in the automotive industry, DMU handles the creation of assemblies with components. And equipment, analysis and simulation, such as assembly process, movements and space exploration, collision testing, assembly and installation simulation, DMus is usually associated with the simulation process. The actual product model data forms the basis of the DMU process. Data transmission can use native CAD data or neutral data formats (such as STEP, IGES, etc.). All the work of the model must be completed in the DMU environment. In fact, a single environment will disappear sooner or later, and will not be used by others. The designer must fully grasp this new technology and must first enter the DMU environment in the morning so that all design work can be performed on it during the day.

The concept Of DMU originated in late 1980s shortly after the adoption of 3D CAD system.

It was typically provided as an add-on application to CAD systems, i.e., DMU

applications are provided as standalone application that are not integrated with CAD authoring tools or with the overall PLM solution, product data management (PDM) OR computer aided manufacturing (CAM) applications.

Benefits of Digital Mock-Up

The main benefits of digital mock-up process are as follows;

1. The time to the market is reduced.
2. Improvement of quality of the product and optimization of design.

The cost of the product will be reduced in all processes.

4. Building Virtual Product Models

On the basis of product data models virtual product development process are able to represent the specific product characteristics. The engineers and designers use 3D modelling CAD software to build a realistic 3D models of different parts and assemble them to make a single product.

The mathematical representation is the geometric modelling of an objects geometry. In the entire process of geometric modelling the computer converts various inputs/ commands given from within the CAD software into mathematical models. These are stored in a file and finally displayed as an image. These files can be open at any time for reviewing, editing etc.

5. Analysing Virtual Product Models

Computer-aided engineering CAE is a term that describes the use of computer software in the product development process, from virtual design and testing of complex analysis algorithms to production planning. Product designers can test and simulate the physical characteristics of products without physical prototypes. In this way, CA helps reduce the

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number of physical prototypes and experiments, and optimize designs to create better and faster products.
To evaluate the product designs, there are many methods, a few methods of CAE analysis are briefly discussed below:

6.1 Finite element analysis (FEA)
The computerized method of product to predict, how a product to reacts to the real world applications/forces, heat, fluid flow, vibration and other physical effects is called finite element analysis.
Finite element analysis is a simulation of a physical phenomenon or any given product, by using a technique called finite element method (FEM).
This technique is used to calculate various physical properties and predict the behaviour of the product in the real physical environment.

6.2 Computational fluid dynamics (CFD)
Computational fluid dynamics is a term which is used for virtual analysing and predicting complex 3D products. Analysis approach in this regard is similar to final element analysis, accept the software used being different. Neutral standard data formats are used to transfer data from 3D CAD model to computational fluid dynamics program.
6.3 Multi-body simulation (MBS)
It is a numerical simulation method in which multi-body systems are composed of various rigid and elastic bodies. These are connected with each other by joints and/or by specific force laws.
Multi-body simulation is a useful tool for conducting motion analysis, it is often used during product development to you always characteristics of comfort, safety and performance.
6. Production (Process) Planning And Control (PPC)
Production planning and control includes the management and organization of related production data and processes. Product data is passed to the planning process. Production planning and control data is organised in bill of materials (BOM). The two most important influencing factors are working schedule and manufacturing resources.

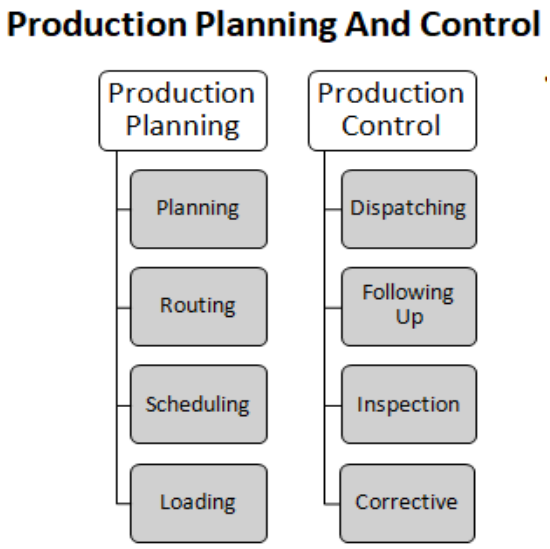

Fig. 3. Elements of planning and control

6.1 Benefits of process planning and control
Some of the benefits of PPC are as follows
1. The inventory investment is reduced.
2. Efficiency is increased and the production cost is reduced
3. All the production processes flow smoothly.
Provides better communication for material procurement.
7. Product Data Technology
Product data technology is defined as the definition and processing of all aspects of product information about the product development and operation life cycle. Product data is classified as follows:
1. Product defining data refers to technical requirements, including all types of data in production specifications.
2. Product describing data refers to the technical documentation of the product, which contains all the information that can be found In the BOM list.

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3. Geometric data refers to CAD model files, data styles, geometric exchange formats, CAD product structures, and other underlying design data.
4. Data Information related to the development process itself includes workflow data, resource management, technical organization data, etc.
5. Product configuration data refers to information about possible variants.

Metadata describes other factors related to the product, such as Productivity. Editable information or data for calculation and organization.

8. Product Structures

Product structure describes the main parts or components, sub-components, assemblies and document forms in a hierarchical way.

Product structure explains the fact regarding how the product is divided into components, which are in turn divided into sub-components, etc., there by giving the essential details in an organized manner.

The product structure apart from containing the 3D model of parts, also contain meta-data that gives all information about parts like material information, manufacturing process, etc.

9. Variant Management And Product Configuration

The general consumer trend is that manufacturers need to provide multiple variants of the same product (product variants) to meet the increasingly diverse needs of customers.

Variant Configuration supports the collection, promotion, ordering and production of complex products designed for customers. By using variant Configuration, product marketing and order entry can be optimized. By selecting predefined parameters, products can quickly adapt to the needs and wishes of customers in the existing structure. , Customers can decide what their product will look like in the end.

For example, when buying an office chair, you can adjust the chair according to your wishes to suit your needs. In addition to this positive impact on customers, Variant Configuration supports the optimization of the company's "information supply chain", from sales and e-commerce, to procurement to production and design.

Variant configuration has a positive impact on customers and manufacturers-these are complex products that can be adapted to customer requirements, can be assembled on time according to customer requirements, control procurement and production costs, experience doubling, use variant settings to manage marketing e-commerce through product information Changes in settings. Example of variant configuration: The image below shows an office chair, highlighting interesting attributes and their value based on market demand and scale.

Fig. 4 Variant Configuration

10. Product Description Data

A data product is digital information that can be obtained. In e-commerce, data brokers can use customer analytics to collect information about specific customer segments for marketing purposes.

Brokers can also collect consumer information from a variety of public and private sources, including court records, census records, and membership card programs. Suggested action The term "data product" is often associated with data science. For example, brokers can use advanced analytics to recommend products that contain anonymous customer data. These profiles use IP addresses to continuously improve customer profiles when end users click on advertisements,

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download books or movies, interact with website forms, collect website cookies, and most importantly create more data. In research, an data product is a large data set in a format that requires little or no processing or programming.

Let us consider an example of a terry cloth gloves. The detailed understanding of the product description data is as follows;

Product description: 100% cotton seamless terry cloth gloves with 24 ounce wrist loops, natural colour. Provide comfortable cut, abrasion and heat protection. The seamless structure provides comfort and breathability. The knitted wristband prevents dust from contaminating the gloves. Has Solid yarn fabric.

11. Data Models

If we combine activities with the concept of a product structure model, a process data diagram will be created. This figure shows the steps required to model the product structure and the results on the right, which are the results of these operations. Some of the commonly used data models are briefed as follows:

12.1 Hierarchical Database Model

This database model is the oldest database form. Because the relationship is established in advance, data can be quickly accessed and updated. This model uses one or more relationships. Since the relationship is constantly established and cannot be changed, it is not flexible.

12.2 Network Database Model

A network database model for network structure, used to create relationships between entities. Data is organized in multiple ways among related records. Unlike hierarchical databases, a node can only have one parent node, which is mandatory. A network node can be assigned to multiple objects.

12.3 Relational Database Model

In the relational database model, data is stored in a table of columns and rows. Each column in the table represents an attribute, and each row represents a data record. Each field in the table represents a data value.

The communication between data is relational. Relational database is the most popular and widely used data management technology in PLM.

12.4 Object-Oriented Model

The object-oriented database model was developed due to the lack of a relational database model that does not support the distribution of databases across multiple servers. In this model, users can define their own data access methods, data representation and operation methods.

12.5 Object-Relational Model

As the name suggests, this model is a hybrid database model that combines the simplicity of the relational model with some advanced features of the object-oriented database model. Essentially, it allows the designer to bind objects to a familiar table structure.

12. Status of Items

Item status is a function tab that instructs the system to determine the status of the item in the document form. The item status determines the item transactions that can be performed in the supply chain management application. For example, if you change the status of a project, you can control it. When the item is included in a sales order, inventory request, purchase order, etc. Users can also control whether to select and send items, use for production, or be out of stock. The item status determines which item transactions are allowed in inventory, production, production planning, and business planning. Item status is usually determined by one of the following categories:

12.1 Pre-shipment status

Shows the status of unshipped goods.

a. The draft item is part of the unapproved purchase order.

b. Inactivity. The article has not been delivered yet. If the network has been configured to prevent automatic product activation, all order items will remain inactive until manual activation.

c. Ready items marked as ready have been activated, but delivery has not yet begun. After activation, it may take up to an hour for the status to change, from "Ready to Ship"

d. Shipment of items awaiting approval needs to be approved by the account administrator or stakeholder.

e. Disapproved Item is rejected by the account manager or stakeholders.

f. The frequency of product shipments is expected to decrease. Out of stock or printouts are not the main reason for poor product delivery.

13.2. The status

After the start of delivery & the status reported for items that have started shipping.

a. The delivering article has an ad impression.

b. Completed-items - The end date of the finished product has been reached and cannot be delivered.

c. Paused- The delivery of the item has been paused.

d. Delivery extended- The item has expired and is being shipped as soon as possible to achieve its goal within the specified

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renewal window. Complete status, so you can't start forecasting on it.

13.3 Undelivered item status

The status of undelivered or undelivered items**.**

a. The inventory has been released. The item has been stopped or cancelled, and your inventory is now available to store other items. In some cases, this status may appear on previously unreserved items. However, in this case, there are signs that the item is out of stock.

b. The archived article is not delivered and has been removed from the active list.

13. Life Cycle of a Single Component

The life cycle of a multi-component building product is different from the life cycle of a single element. Each article has its own life cycle, because not all articles are produced at the same time. For example, when the design of an element enters mass production, a component can be determined through a series of tests before the prototype and production of each component and the life cycle can be determined using the support status of the extended management style. These statuses are grouped in phases. The stage allows you to create tags that can define the test location of the component during its development.

CONCLUSIONS

Product building and structures- Like traditional products, product prototyping is time-consuming and expensive. , A new idea or system emerges-the development of virtual products. Compared with traditional manufacturing, virtual product development has many advantages. Tools such as 3D CAD and digital models play an important role in creating and building products that also include certain components (i.e., virtual product simulation, virtual product analysis, and digital manufacturing).

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