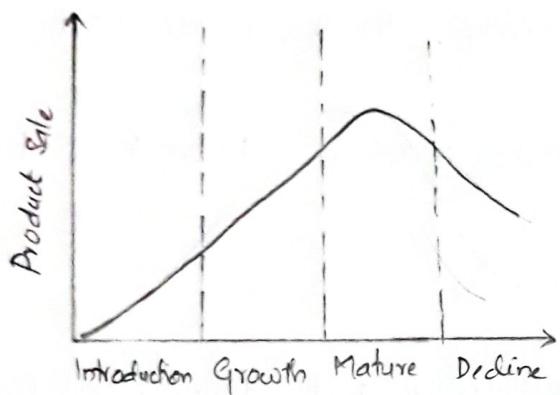


Part - A

1(a)

Product Life Cycle



Product life cycle is based on four states

• Introduction

Here the product is introduced in the market and the objective of the stage is to create awareness and trial of the product launched. In this stage, costs are high and sales and profit are low.

• Growth

Here the product gets into more customers and the objective is to maximize market share. In this stage, sales rise rapidly and the profit rise to peak level.

• Maturity

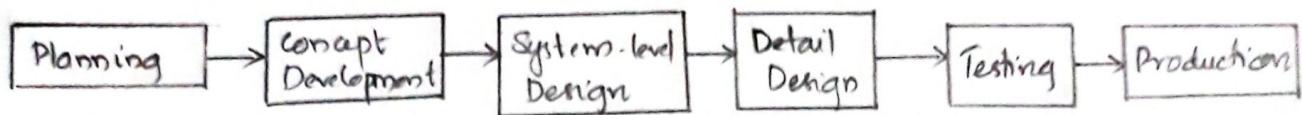
Here the sales rise continue to rise but more slowly and the objective is to maximize profits defending market share. In this stage, profit get stable and the competition is at its peak level.

• Decline

Here the sales decline permanently and the objective is to reduce expenditure and sell the base brand. In this stage sales and profit decline and the product is taken off from the market.

1-(b)

## Product Development Process - Stages



Product development is the set of activities starting with the perception of market opportunity and ending with the production, sale and delivery of a product.

The product development Team includes : Marketing → Design → Manufacturing

### I Planning

→ Marketing :

• Identify the market opportunity and define market segments

→ Design :

Identify the product platform and architecture and access new technologies

→ Manufacturing :

Identify the product constraints and setup supply chain management system.

Planning stage is also known as 'phase 0' (Preceding project approved).

### II Concept Development

→ Marketing :

Marketing team gather the customer needs and then identify the lead users. They also identify competitive products.

→ Design :

Study the feasibility of product concepts and develop industrial design concept and then build and test the proof of concept models.

→ Manufacturing :

They estimate manufacturing cost and access production-feasibility.

### III System-level-Design

#### → Marketing:

Develop plan for product options and extended product family.  
They set target pricing.

#### → Design:

Generate alternate product architecture and decide major subsystems and interfaces and then refine industrial design

#### → Manufacturing:

Identify suppliers for key components and performs market-buy analysis  
They define final assembly scheme and set target cost.

### IV Detail Design

#### → Marketing:

Develop marketing plan

#### → Design:

They define part geometry and assign tolerance. They decide on materials and complete industrial design documentation.

#### → Manufacturing:

They finalize part production process and they design toolings.  
They define quality assurance process and begin procurement of long-lead toolings.

### V Testing and Refinement

#### → Marketing:

They develop promotion and launch materials and facilitate field testing

#### → Design:

Testing of performance, reliability and life and they obtain regulatory approvals and implement design changes

→ Manufacturing:

They finalize vendor development and refine production and assembly processes. They train work force and refine quality assurance processes.

## vi Production

→ Marketing:

Place early production with key customers

→ Design:

Evaluate early production output

→ Marketing: Manufacturing:

Start operation of entire production system.

## 2.(b) Needs and Goals of Industrial Design

The Industrial & Designers Society of America defines Industrial Design as "the professional service of creating and developing concepts and specifications that optimize the function, value and appearance of products and systems for the mutual benefit of both user and manufacturer."

### → Needs and goals of ID

There are five critical goals that industrial designers can help a team to achieve when developing new products:

- (1) Utility: The product's human interfaces should be safe, easy to use and intuitive.
- (2) Appearance: Form, line, proportion and colour are used to integrate the product into a pleasing whole

(3) Ease of maintenance

(4) low costs

(5) communication

→ Ergonomics Need

• Ease of use:

- Ease of use may be extremely important both for frequently used products such as photocopier and for infrequently used products such as fire extinguisher.
- Ease of use is more challenging if the product has multiple features and modes of operation that may confuse or frustrate the user.

• Ease of maintenance:

- If the product needs to be serviced or repaired frequently, then ease of maintenance is crucial.

• User interactions:

- The more the interactions users have & with the product, the more the product will depend on ID.

• Safety issues:

All products have safety considerations. For some products there can present significant safety challenges to the design team.

→ Aesthetic Need

• Visual product differentiation

Products with stable markets and technology are highly dependent upon ID to create an aesthetic appeal and hence visual differentiation.

- Pride of ownership, image & fashions

A customer's ~~perce~~ perception of a product is to ~~part~~ based upon its aesthetic appeal. An attractive product may be associated with high fashions and image.

### Part-B

6.(a)

Value Engineering	Value Analysis
<ul style="list-style-type: none"> <li>• It is an application of creative techniques for increasing the value and function for New Products at the design stage itself, to minimize the cost of the product</li> <li>• It is done before the fact at pre-manufacturing stage, so a Preventive process</li> <li>• It indicates application on the product at its design stage.</li> <li>• VE is always done by a specific product design (engineers) team</li> <li>• The changes are executed at the initial stage only</li> <li>• It requires specific technical knowledge.</li> </ul>	<ul style="list-style-type: none"> <li>• It is an application of creative techniques for increasing the value &amp; functions to an already existing product / service to minimize the cost of that product.</li> <li>• This is like a post-mortem analysis, done after the fact, so a Remedial Process</li> <li>• It indicates application on the product that is into manufacturing</li> <li>• In VA all factors come together including workers, subcontractors, engineers to make a team with total experience and knowledge.</li> <li>• It may change the present stage of the product or operations</li> <li>• It is worked out mostly with the help of knowledge and experience.</li> </ul>

6.(b)

## Product Costing

Product cost refers to the costs incurred to create a product. There are 3 major components of cost of products. They are material cost, labour cost and expense cost.

### Components of cost

#### → Material cost

Material indicates principal substances used in production. The cost of material is further divided into direct and indirect materials.

##### • Direct Material

It refers to the cost of materials which become a major part of the finished product. Direct material is one which goes into a sellable product or its use is directly essential for the completion of that product. They are raw materials that become the integral part of the finished product.

##### • Indirect Material

These are materials which are used ancillary to manufacture and cannot be traced into the finished product. It is one which is necessary in the production process but is not directly used in the product itself. These form a part of manufacturing overhead.

#### → Labour cost

Labour is the physical or mental effort expended on the production of an item. It is the active factor of production. It is the cost of remuneration, wages, salaries, commissions of the employees of an enterprise.

- Direct Labour Cost

It is defined as the labour associated with workers who are engaged in the production process. It is the labour costs for specific work performed on a product that is conveniently and economically traceable to end products. It is expended directly upon the materials comprising the finished product.

- Indirect Labour Cost

This includes wages paid for all labour which is not directly engaged in changing the shape or composition of raw materials. It cannot be traced directly to the product. Indirect labour forms part of the manufacturing overheads.

→ Expenses Cost

- It is a collective title which refers to all charges other than those incurred as direct result of employing workers or obtaining material.

- Direct expense cost

Direct expense can include any expenditure other than direct material and direct labour directly incurred on a specific cost unit. Such special necessary expenses can be identified with cost units and are charged directly to the product as part of the prime cost.

- Indirect Expense cost

Indirect expense are those incurred for the business as a whole rather than for a particular order, job or product.

→ Overheads

Overheads may be defined as the aggregate of indirect material, indirect labour and indirect expenses. Thus all indirect costs are overheads. These cannot be associated directly with the specific products.

Part - C

8.(a)

Creative Process

Creativity is defined as the skill of being able to produce something a new product, an idea, a concept or a solution to a specific problem by having some value. Creativity Techniques are:

(D) Brainstorming

Brainstorming is a means of generating ideas. It can be used to identify alternatives, obtain a complete list of items and to solve problems.

→ Brainstorming steps:-

Brainstorming <sup>group</sup> consist of 10-12 people including a leader, a person in charge of noting down the proceedings and regular or guest members. Person who poses the problem is also usually present.

• Process of brainstorming are.

(1) Set the environment : location, room, materials etc.

(2) Setting the scene : explaining the technique, etc.

(3) Rules of the session : criticism is not allowed, wild ideas are allowed and encouraged etc.

- (4) Running the session : Questioner states the problem with necessary explanations & clarifications and problem is refined with i/p's of the team.
- (5) Affinity analysis
- (6) Summary and further action.

### (2) Gordon Technique

The Gordon technique ~~involves~~ involves developing new ideas when the individuals are ~~completely~~ unaware of the problem. This implies that group members do not know the exact nature of the problem. The entrepreneur begins by mentioning a general concept associated with the problem. The group thereafter responds by expressing a no. of ideas. This can be lead to a concept being developed, followed by related concept through guidance by the entrepreneur. At last the actual problem is revealed, enabling the group to make suggestions for the implementation or refinement of the final solution.

### (3) Check listing

Checklist provide ~~are~~ not only a means of evaluation but also an operational definition of teaching objectives, a guide to learning, and an outline for curriculum development. Generating checklists can offer new insights into the subject matter and teaching strategies. If students are involved, the process can become an exciting and powerful teaching and learning experience.

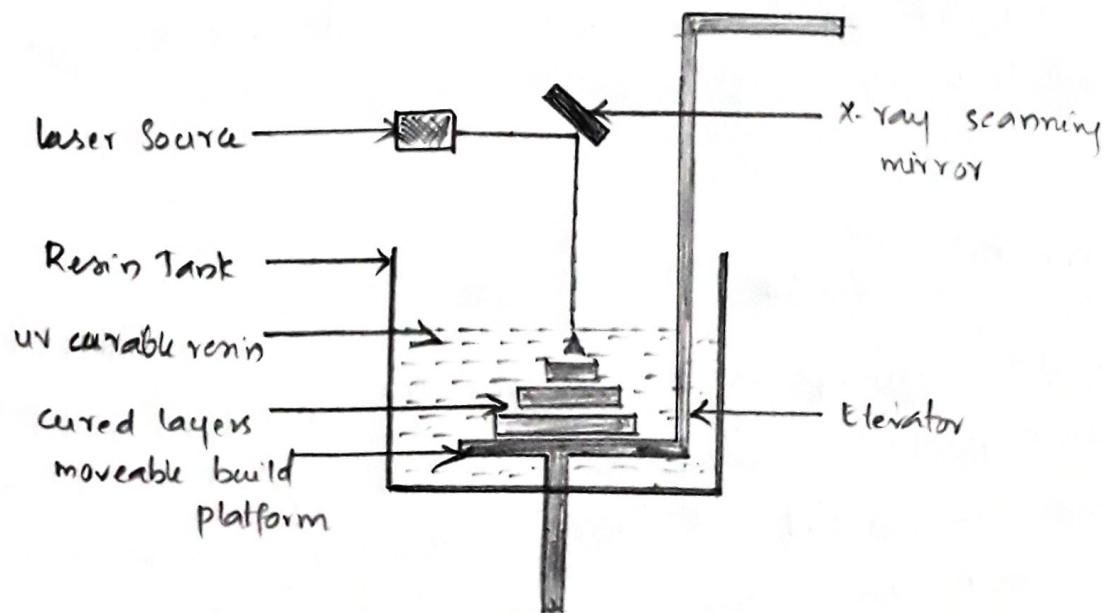
#### (4) Six Thinking hats

- Six Thinking hats
- (Blank paper) White hat - facts known or required.
  - (Judge) Black hat - Judgment of how/ where something can go wrong
  - (Sunshine) Yellow hat - optimism and brightness
  - (Vegetation) Green hat - creativity (alternatives, possibilities)
  - (Fire) Red hat - hunches, intuition and feelings
  - (Sky) Blue hat - management

(8-b)

#### Rapid Prototyping Technique.

⇒ Stereo lithography



Stereolithography process is based on the principle of curing a liquid photopolymer into a specific ~~shape~~ shape. A vat containing a mechanism whereby a platform is at its highest position depth and the layer of liquid above it is shallow. A laser generating an UV-beam, is now focussed upon a selected surface area of a prepolymer photopolymer and then moved in x-direction. The beam cures that part position of the photopolymer and thereby produces a solid body. The platform is then lowered sufficiently to cover the cured polymer with another layer of liquid polymer.

The part has been produced from the bottom up in ~~individually~~ individual slices. The uncured portion of the liquid polymer can be used again to make another part or another prototype in stereolithography. This support takes the form of a perforated structure. After its completion, the part is removed from the platform, blotted and cleaned ultrasonically and with an alcohol bath, then the support structure is removed and the part is subjected to final curing cycle.

9.6)

### Concurrent Engineering

Concurrent engineering is a business strategy which replaces the traditional product development process with one in which tasks are done in parallel and there is an early consideration for every aspect of a product's ~~development~~ development process.

This strategy focuses on the optimization and distribution of a firm's resources in the design and development process to ensure effective and efficient product development process. Concurrent engineering methodologies permit the separate tasks of the product development process to be carried out simultaneously rather than sequentially. Potential problems in fabrication, assembly, support and quality are identified and resolved early in the design process.

### Need of concurrent Engineering

- React to the changing market needs rapidly, effectively and responsively
- To reduce their time to market and adapt to the changing environments.
- Decisions must be made quickly and they must be done right the first time out.

### Advantages

- Decrease in time to market
- Increases product life cycle Profitability
- Increase ~~product~~ productivity
- Faster product development.
- less work in progress
- Reduce design and development times.
- Company operates more efficiently.

Q.1(b)

Intellectual property is the product or creation of the mind. It is different from other properties in term that it is intangible. Hence it needs some different way for its protection.

Intellectual property right (IPR) is the body of law developed to protect the creative people who have disclosed their invention for the benefit of mankind.

→ Types and ways to protect IPR →

(1) Patent

A patent is a grant from the govt. gov. which confers on the grantee for a limited period of time the exclusive privilege of making, selling and using the invention for which a patent has been granted.

(2) Trademark

(3) Trade Secret

(4) Copyright

Part - A .

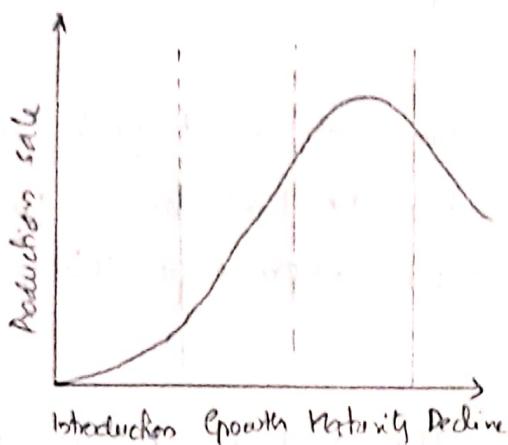
- (1) Discuss the different types of customer needs related to the product they use.
- (2) Explain product life cycle of a manufactured product
- (3) What are the primary roles of development team members in conceptual design process?
- (4) Describe the 'Kano Diagram' of customer satisfaction

Part - B .

- (1) Sketch a 'Need - Matrix' matrix for the design of a typical electro mechanical product of household use with eg.
- (2) Explain any 1 method of eliciting customer requirements as part of concept development
- (3) with sketches, give eg of different product architectures.
- (4) Explain how variabilities occur in product pre-performance and how to make product robust

## Part - A

### (2) Product life cycle.



In Product life cycle there are 4 stages.

#### (i) Introduction

Here the product is introduced in the market. The objective of this initial stage is to create awareness and trial of the product launched.

Features of this stage are:

- Costs are high
  - Few competitors
  - Sales and Profit are less
  - Relatively high price
  - Covers less market.
- (ii) Growth
- Product gets in more customers and its objective is to maximize the market share.
- Features include :
- Sales increase rapidly and profit is at peak level.
  - Price decreases and there will be increase in competitors.

### (3) Maturity

Here the sales continue to rise but more slowly. The objective of this stage is to maximize profits defending market share.

Features of this stage are:

- Profit gets stable and the competition is at peak level
- Price reduces and little growth potential for the product.
- Product is established and promotion expenditure is less.

### (4) Decline

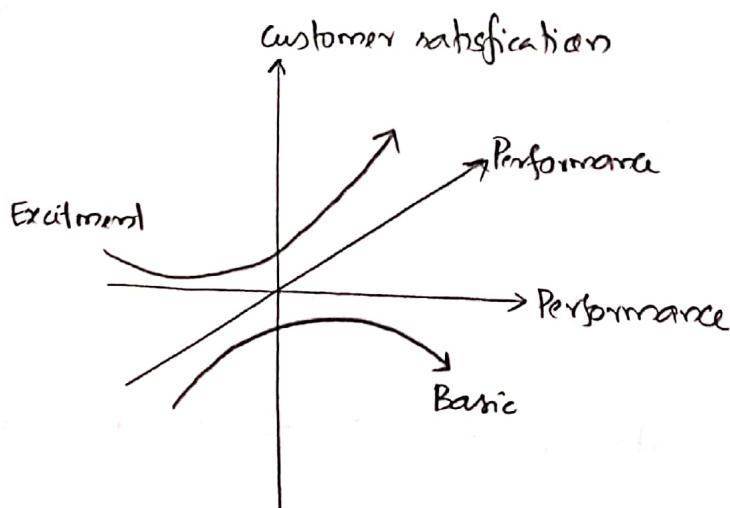
Here the sale decline permanently and the objective of this stage is to reduce expenditure and sell the brand. In this stage the expenditure begins to equal the profits or worse.

Features are:

- market is saturated and sales and profit decline.
- Resources are blocked and the product is taken off.

### (3) (4)

### Kano Diagram



In Kano Diagram, as the customer satisfaction increases the performance also increases. The

In Kano Diagram, as the performance of the company increases, customer satisfaction also increases depending on performance.

when the performance slightly increases and the customer satisfaction rapidly increase then it is known as Excitement.  
when the performance increases and the customer satisfaction decreases then it is known as Basic.

## (1) Different types of customer needs :-

- Function

It should be functional as quick as possible may be in a one or two step.

- Reliability

It should be reliable

- Maintainability

If the product get damage it should be maintained well in quick access.

- Product's Productibility

The parts of the product must be available in nearby places so that the production must be high.

- Simplification

The product must be in a simplified format.

- Quality

The quality of the product should be quite good and it should be a top brand.

- Minimum cost

The cost of the product must be minimum as compared to the quality.

- (ii) In conceptual design process the development team, starts in starts with a set of useful solutions that can be prototyped or applied in an operation. The purpose of primary design is to find the best design alternatives. The roles of The primary roles will be based on formation of mathematical model, sensitivity analysis, formal optimization and simplification.
- ↳ Through concept selection the concepts which are selected is screened and concept screening and concept scoring takes place.

### Part - B

- (i) Need- Matrices of electro-mechanical model product of eg:- Automatic Coconut Grinder.

Need	Matrix	water proof resistant	Attenuation is given to handle.	Affordability	Adjustable	Time to assemble using nano electronics.	Bonding strength	Amenable for maintenance
Affordable				*				
Reduce vibration to hands			*					
Easy to install					*			
Not too light weight						*		
Not destroyed by water		*						
Can be easily arrested for maintenance							*	
Available for all size					*			
Should be safe in crash							*	
Easy to install					*			
long lasting						*		

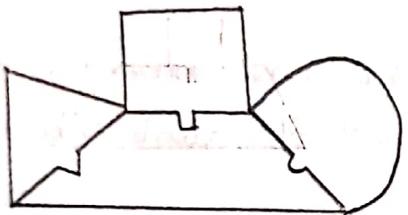
### (3) Types of Product architecture:

#### • Modular architecture

In modular architecture the chunks implement one or few functional elements in their entirety. The interactions b/w chunks are well defined and are generally fundamental to the primary functions of the product.

Modular archt architecture is of 3 types:-

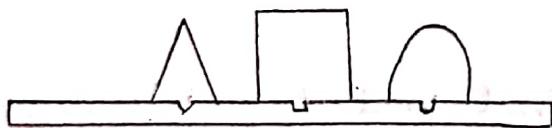
#### • Slot- Modular Architecture:



Each of the interfaces b/w chunks in a slot-modular architecture is of a diff. type from the others.

eg:- car stereo & speedometer

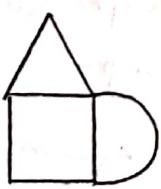
#### • Bus- modular architecture



eg:- memory card & sharing spm.

In a bus modular architecture, there is a common bus to which the other chunks connect through the same type of interface.

#### • Sectional- modular architecture



In this architecture, all interfaces are of the same type, but there is no single element to which all the other chunks attach.

#### • Integrated Architecture

Functional elements of the product are implemented using more than one chunk. A single chunk implements many functions.

(4) Variabilities occur in product performance through intended and unintended factors i.e., from noise factors. There are 3 noise factors :-

- Internal variation

Internal variation is due to the internal factors of the product.

e.g:- wear & tear.

- External variation

External variation is due to the environmental factors such as ambient temperature, humidity, dust, vibrations etc.

- Unit-unit variation

Variations caused by variation in materials, manufacturing tolerance, tool deviations etc are called unit-unit variation.

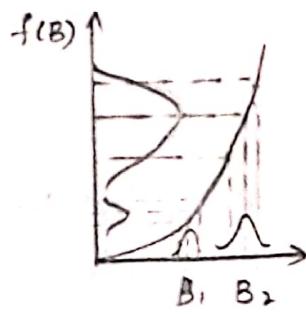
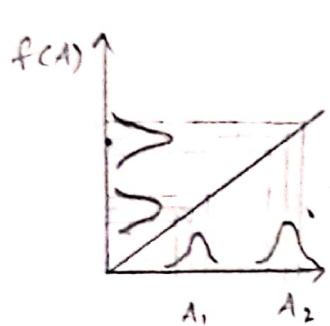
Robust Product is one that product as intended even under known ideal condition such as manufacturing causes variation range of operation situations. To make the product robust minimize the noise factor or the quality of the product must be opposite to product factor. Through functional design, parametric design and tolerance design we can make robust.

Functional design is also known as system design. In it there are 2 types conceptual & functional design. Conceptual design is forming the ideas and functional design is identification of subclans and integration of the sys to achieve the design.

Parametric design is the selection of right set point under designer control. The factor set points are selected where they are least sensitive to noise.

## Tolerance Design

It is based on the tolerance of the product.



(1) Method by communicating method

(2) Soliciting customer requirement can be by communicating method.

In communicating method,

- Verbal description:-

It is generally a short paragraph or a collection of points summarizing the product concept.

- Sketch

Sketches are usually drawn line drawing showing the product in perspective, perhaps with annotations of key features

- Photos and renderings:

Photographs can be used to communicate the concept when appearance models exist for the product concept. Renderings are near photo-realistic illustrations of the concept.

- Story board :

It is a series of images that communicates a temporal sequence of actions involving the product.

- Video :

Video Images are allow even more dynamics than story board. With the video , the forms of the product itself can be clearly communicated , as can the way in which the product is used.

### Part-A

(2) Q2

- Value Analysis (VA) is the application of creative techniques for increasing the value and functions to an already existing products / services to minimize the cost of that product. This is like a Post-mortem analysis is done after fact, so a Remedial Process. VA indicates application on the product that is into manufacturing. In VA all factors come together including workers, subcontractors, engineers to make a team with total experience and knowledge. It may change the present stage of the product or operation. It is worked out mostly with the help of knowledge and experience.
- Value Engineering (VE) is the application of creative techniques for increasing the value and function for New Products at the design stage itself, to minimize the cost of the product. This is done before the fact at pre-manufacturing stages such as concept development and design, so a Preventive Process. VE indicates applications on the product at its design stage. VE is always done by a specific product design or engineering team. In VE, the changes are executed at initial stages only. It requires specific technical knowledge.

(I) The cash flows related to a successful product of an enterprise depends on Quantitative Analysis and Qualitative Analysis.

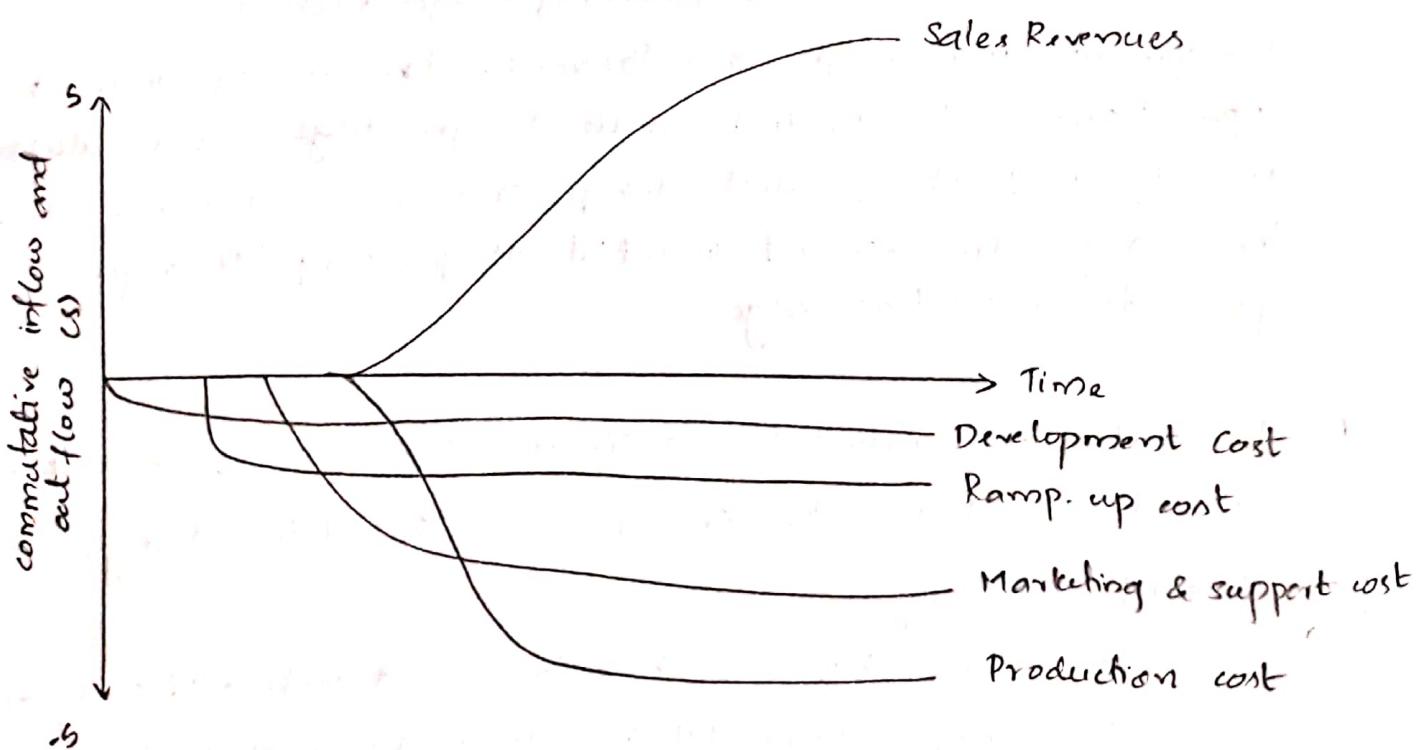
Quantitative Analysis:-

There are several basic cash inflows and cash outflows in the life cycle of a successful new product. Cash inflow comes

from product sale and cash outflows where include spending on product and process development i.e., cost of production, equipment purchases and tooling, cost of marketing etc. Economically successful products are profitable, that is they generate more cumulative inflows than cumulative outflows. A measure of the degree to which inflows are greater than outflows are called the net present value (NPV) of the project. The quantitative part of the economic method analysis method estimates the NPV of a project's expected cash flows. NPV techniques were used since they are easy to understand.

### Qualitative Analysis:-

It can only capture only those factors that are measurable, yet projects often have both +ve and -ve implications that are difficult to quantify. Qualitative analysis rarely captures the characteristics of a dynamic and competitive environment. One approach to qualitative analysis is to consider specifically the interactions b/w the project and the (i) firms, (ii) market and (iii) microeconomic environment.



(3)

Gestalt Principles are used to make the designs more coherent.

A group of psychologist in Germany developed a series of theories of visual perception known as Gestalt Theory. Gestalt Principles form the basis of many design rules. It is important for a graphic and web designer to have knowledge on Gestalt principles.

There are 6 Gestalt Principles. They are; Similarity, Continuation, closure, Proximity, Figure/ ground and Symmetry and order.

(1) Similarity :- When objects look similar to one another, viewers will often see the individual elements as a part of a pattern or group. This effect can be used to create a single illustration, image or message from a series of separate elements. The similarity b/w different elements can be in shape, colour, size, texture or value.

(2) Continuation :- Continuation is the principle through which the eye is drawn along a path, line or curve. This can be used to point towards another element in the composition and is seen where a line is cut through one object, often in a curve, aligning perfectly with a secondary element.

(3) Closure :- Closure is a common design technique that uses the human eye's tendency to see closed shape. Closure works where an object is incomplete or the interior space of an element is not fully closed, but the viewer perceives a complete shape by filling in the missing information.

(4) Proximity :- Proximity (aka grouping) uses the close arrangement of start elements to create a group association b/w those

objects. If individual elements are also similar, they will tend to be perceived as a single whole, even though they are separate elements. It can be achieved by with lots of different commonality including shape, colour, texture etc.

- (5) Figure / Ground:- This principle describes the eye's tendency to see and separate objects from their surrounding background.

(4)

Different methods to enhance the aesthetic appeal of a product are,

(1) Shape and size

(2) Colour

(3) Style

(4) Symmetric and balance

(5) Variety

(6) Continuity

(7) Contrast

(8) Texture

(9) Material and surface finish

(10) Harmony.

Shape:- The external shape of any product can be given is based on the one or combination of basic shapes.

Size:- Due to the miniaturization of the advanced technology size is an important factor.

Colour:- colour is the important factor i.e., creating interest, eliminating eye fatigue, directing attention etc.

Style:- It is a visual quality of the product which set it apart from the rest of the functionally identical products.

Symmetry suggest a state of order but asymmetry can create a greater sense of interest. Symmetry increase visual attraction.

Variety is particularly important in marketing range of product like fans, vehicles etc. Continuity is associated with the order or tidiness of the product. Contrast is distinction b/w adjustment elements of the product which have clearly different characteristics and functions. Texture refers to surface quality i.e., Smooth, Metallic, Sandy, Spongy etc. Material and Surface finish of the product contribute significantly to the appearance i.e., the product is smooth or hard etc. Harmony or Rhythm is the presentation of a design in accordance with the context or background.

- (5) Most designers communicate their design ideas through many different mediums. These include, drawing, tooling and sampling. By drawing they can show the clients about the ideas or structure of the product and the schematic of the product. Through drawing, we can show how it works, the block level presentations can also be shown. By showing the sampling samples of product we can communicate the ideas. & Showing the same feature product or working model the design ideas can be given.

### Part - B

- (1) Rapid prototyping technology employs various engineering eg. computer control and software techniques including laser, optical scanning, photo sensitive polymers, material extrusion and deposition etc. to directly produce a physical model layer by

layer by layer manufacturing in accordance with the geometrical data delivered from a 3D CAD model. It is produce a model by adding materials layer by layer. It is an addition process and no tooling is required. Parts are assembled in one stage. The errors and flaws can be detected at early stage.

### Types of Rapid Prototyping:-

#### (i) Liquid Based

- Liquid based Rapid prototyping systems have the initial form of its material in liquid state. Through a process commonly known as curing, the liquid is converted into the solid state.  
eg:- Stereolithography

#### (ii) Solid Based

- Except for powder, solid based RP systems are meant to encompass all forms of material in the solid state.  
eg:- Fused Deposition Modelling.

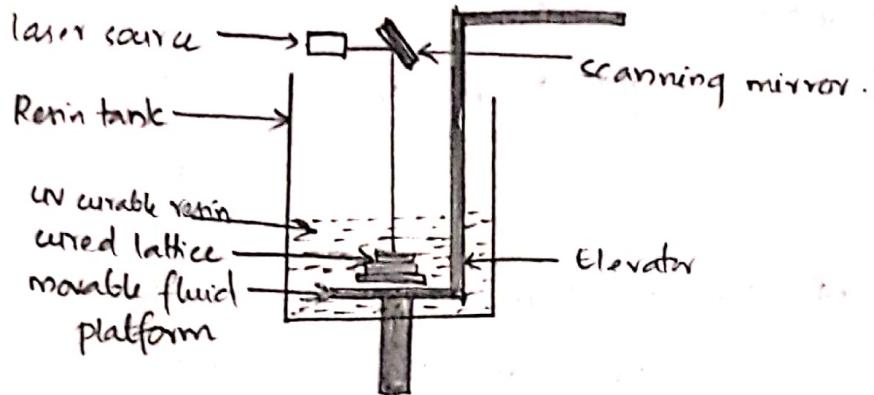
#### (iii) Powder Based

However it is intentionally created as a category outside the solid based RP s/m to mean powder in granular-like form.

eg:- Selective laser Sintering.

#### → Stereolithography

Stereolithography is based on the principle of using a liquid photo polymer into a specific shape. A ~~coac~~ contains a ~~reactions~~. This process ~~and~~ involves curing a liquid polymer into a specific shape.



A vat containing a platform is at its highest position depth and the layer of liquid above it is shallow. A laser is generating. An ultraviolet beam is generated from the laser and it is focussed upon a selected surface area of the photopolymer and then moved in  $x-y$  directions. The beam cures that portion of the photopolymer and thereby produces a solid body.

(3)  $\rightarrow$  Intellectual Property is the product or creation of the mind. It is different from other material properties in term that it is intangible. Hence it needs some different way for its protection. Intellectual Property Right (IPR) is the body of law developed to protect the creative people who have disclosed their inventions for the benefit of mankind. This protects their inventions from being copied or imitated without their consent.

$\rightarrow$  Methods for Safeguarding it :-

#### (1) Patent

A patent is a grant from the govt. which confers on the guarantee for a limited period of time the exclusive

exclusive privilege of making, selling and using the invention for which a patent has been granted.

### (3) Trademark

Exclusive right given by govt. to the trademark owner to use a specific name or symbol in association with a class of product or process. Normally trademarks are typically brands or product name.

### (3) Trade Secret :-

A trade secret is information used in a trade or business that offers its owner a competitive advantage and that can be kept secret. A symbol, logo, word, sound, colour or other device used that is used to identify a business or a product in commerce.

### (4) Copyright :-

Exclusive right granted by the government to copy and distribute an original work of expression, whether literature, graphics, music, art or software. Registration of a copyright is possible but not necessary. It can be upto 95 years.