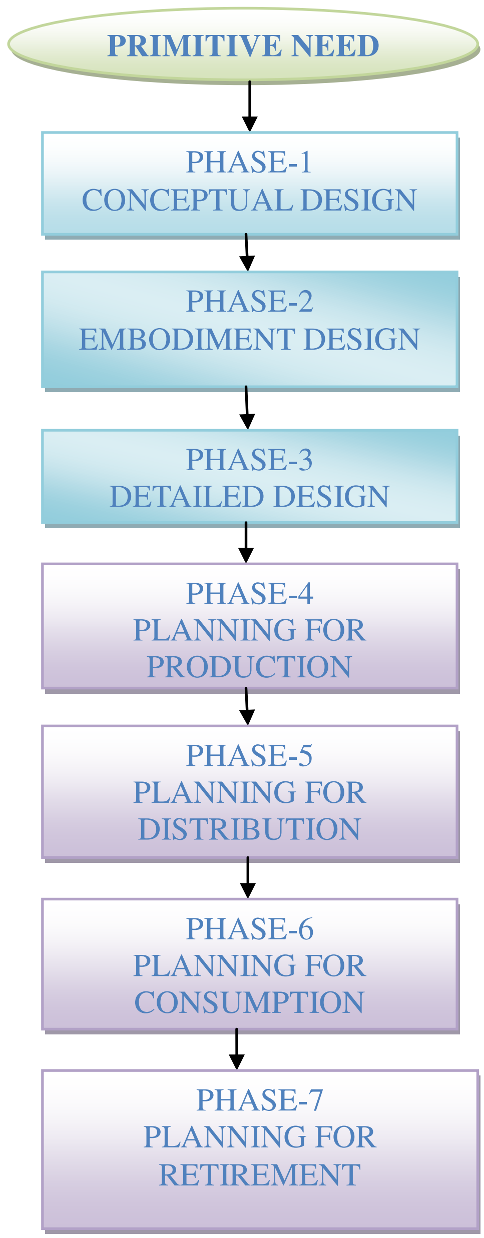
Unit-03/Lecture-01
Description of Design Process

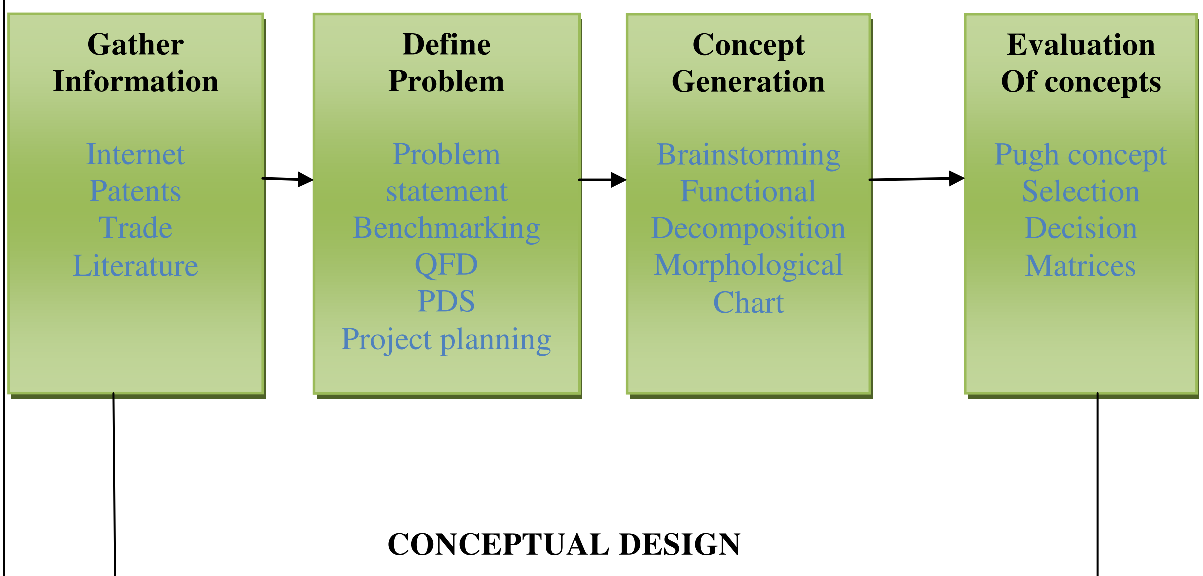
Description of Design Process :

Morris Asimow was along with the first to give a detailed explanation of the complete design process in what he called the **morphology of design**. It is defined by the phases and their constituent steps. Design is succession from the abstract to the concrete. The various activities that make up the first three phases of design**: conceptual design, embodiment design, and detail design** & the remaining four phases belong to **production, distribution, consumption & retirement.**



Phase-1 : Conceptual Design/ Feasibility study

Conceptual design is the process by which the design is initiated, carried to the point of creating a number of possible solutions, and narrowed down to a single best concept. It is sometimes called the feasibility study. A design begins with a feasibility study; the purpose is to achieve useful solutions to the design problem. Sometimes a design group is assigned a project for which a design concept has been fixed. Conceptual design is the phase that requires the greatest creativity, involves the most uncertainty, and requires coordination among many functions in the business organization. The following are the discrete activities that we consider under conceptual design



a) **Identification of customer needs:** The goal of this activity is to completely understand the customers' needs and to communicate them to the design team. Engineers and business people are seeking answers to such questions as:

Who are my customers?

What does the customer want?

How can the product satisfy

The customer while generating a profit?

Information gathered from customers and research on products from market literature and experimentation contributes to creating a ranked listing of customer needs and wants. These are the needs that form the end user's opinion about the quality of a product. As odd as it may seem, customers may not express all their requirements of a product when they are interviewed. If a feature has become standard on a product **(e.g., a remote control on a TV)** it is still a need but no longer excites the end users, and they may forget to mention it. To understand how that can happen and how the omissions can be mitigated, it is necessary to reflect on how customers distinguish **"needs."**

Physiological needs*:* such as thirst, hunger, sleep, shelter, and exercise. These constitute the basic needs of the body, and until they are satisfied, they remain the prime influence on the individual's behavior.

Safety and security needs: which include protection against danger, **deprivation (lack)**, and **threat (hazard)**? When the bodily needs are satisfied, the safety and security needs become dominant.

Social needs: for love and **esteem (appreciate)** by others. These needs include belonging to groups, group identity, and social acceptance.

b) **Problem definition:** The goal of this activity is to create a statement that describes.
What has to be accomplished to satisfy the needs of the customer? This involves analysis of competitive products, the establishment of target specifications, and the listing of constraints and trade-offs. **Quality function deployment (QFD)** is a valuable tool for linking customer needs with design requirements. A detailed listing of the product requirements is called a **product design specification (PDS)**. Problem definition, in its full scope

c) **Gathering information:** The need for information can be crucial at many steps in a design project. We will need to find these bits of information quickly, and validate them as to their reliability

i) Data, information, knowledge: ***Data*** is a set of discrete, objective facts about events. These data may be experimental observations about the testing of a new product, or data on sales that are part Of a marketing study.

Information is data that has been treated in some way that it conveys a message. Information is meant to change the way the receiver of the **message** perceives something, i.e., to have an impact on his or her judgment and behavior. The word *informs* originally meant **"to give shape to."**

Data becomes information when its creator adds meaning. This can be done in the following ways.

Contextualized: we know for what purpose the data was gathered.

Categorized: we know the units of analysis or key components of the data.

Calculated: the data have been analyzed mathematically or statistically.

Corrected: errors have been removed from the data.

Condensed: the data have been summarized in a more concise form.

Knowledge is broader, deeper, and richer than data or information. Because of this it is harder to define. It is a mix of experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. This transformation occurs through the following processes:

Comparison: how does this situation compare to other situations we have known?

Consequence: what implications does the information have for decisions and
Actions?

Connections: how does this bit of knowledge relate to others?

Conversation: what do other people think about this information?

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d) **Conceptualization:** Concept generation involves creating a broad set of concepts that potentially satisfy the problem statement. Team-based creativity methods, combined with efficient information gathering, are the key activities.

One way to increase the likelihood of positive outcomes is to apply methods found to be useful for others. Following are some positive steps you can take to enhance your creative thinking

i) Develop a creative attitude: To be creative it is essential to develop confidence that you can provide a creative solution to a problem. Although you may not visualize the complete path through to the final solution at the time you first tackle a problem, you must have selfconfi dence; you must believe that a solution will develop before you are finished. Of course, confi dence comes with success, so start small and build your confidence up with small successes.

ii) Unlock your imagination*:* You must renew the glowing imagination you had as a child. One way to do so is to begin to question again. **Ask "why" and "what if,"** even at the risk of displaying a bit of inexperience. Scholars of the creative process have developed thought games that are designed to provide practice in unlocking your imagination and sharpening creative ability.

iii) Be persistent: We already have dispelled the myth that creativity occurs with a lightning strike. On the contrary, it often requires hard work. Most problems will not submit to the first attack. They must be pursued with persistence. **After all, Edison tested over 6000 materials before he discovered the species of bamboo that acted as a successful filament for the incandescent light bulb. It was also Edison who made the famous comment, "Invention is 95 percent perspiration and 5 percent inspiration."**

iv) Develop an open mind: Having an open mind means being approachable to ideas from any and all sources. The solutions to problems are not the property of a particular discipline, nor is there any rule that solutions can come only from persons with college degrees..

v) Suspend your judgment : We have seen that creative ideas develop slowly, but nothing Slow up the creative process more than critical judgment of an emerging idea. Engineers, by nature, tend toward critical attitudes, so special patience is required to avoid judgment at an early stage of conceptual design.

vi) Set problem boundaries : We place great emphasis on proper problem definition as a step toward problem solution. Establishing the boundaries of the problem is an essential part of problem definition. Experience shows that setting problem boundaries appropriately, not too tight or not too open, is critical to achieving a creative solution.

e) **Concept selection:** Evaluation of the design concepts, modifying and evolving into a single preferred concept, are the activities in this step. The process usually requires several iterations. Theory for decision making is rooted in many different academic disciplines, including pure mathematics, economics (macro and micro), psychology (cognitive and behavioral), probability, and many others

Behavioral aspects of Decision making:

Behavioral psychology provides an understanding of the influence of risk taking in individuals and teams. Making a decision is a stressful situation for most people because there is no way to be certain about the information about the past or the predictions of the future. This psychological stress arises from at least two sources. **First,** decision makers are concerned about the material and social losses that will result from either course of action that is chosen. **Second,** they recognize that their reputations and self-esteem as capable decision makers are at stake.

i) **Unconflicted adherence:** Decide to continue with current action and ignore information About risk of losses.

ii) **Unconflicted change:** Uncritically adopt whichever course of action is most Strongly recommended.

iii) **Defensive avoidance:** avoid conflict by delay, shifting responsibility to Someone else, and remaining careless to corrective information.

iv) **Hyper vigilance:** Search madly for an immediate problem solution.

v) **Vigilance:** Search carefully for relevant information that is understand in an Unbiased manner and evaluate carefully before a decision is made.

f) **Refinement of the PDS:** The product design specification is revisited after the concept has been selected. The design team must commit to achieving certain critical values of design parameters, usually called **critical-to-quality (CTQ)** parameters, and to living with trade-offs between cost and performance.

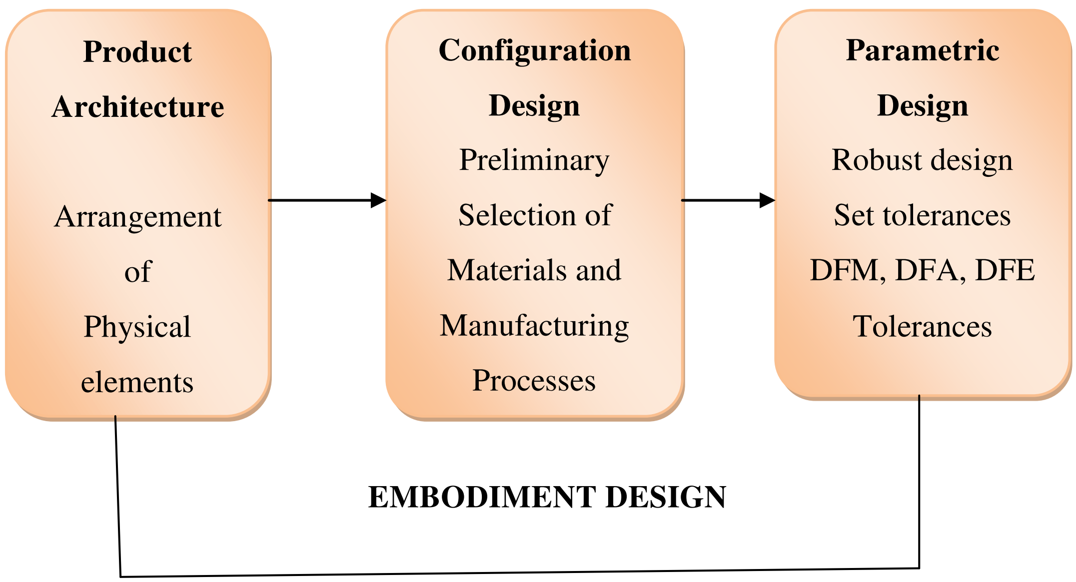
g) **Design review:** Before committing funds to move to the next design phase, a design review will be held. The design review will assure that the design is physically realizable and that it is economically worthwhile. It will also look at a detailed product development schedule. This is needed to devise a strategy to minimize product cycle time and to identify the resources in people, equipment, and money needed to complete the project.

Unit-03/Lecture-02

EMBODIMENT DESIGN/ preliminary design:

The next phase of the design process is often called embodiment design. It is the phase where the design concept is invested with physical form, where we **"put meat on the bones."** Structured development of the design concept occurs in this engineering design phase. An embodiment of all the main functions that must be performed by the product must be undertaken. It is in this design phase that decisions are made on strength, material selection, size, shape, and spatial compatibility. Beyond this design phase, major changes become very expensive. This design phase is sometimes called **preliminary design.**

Embodiment design is concerned with **three major tasks—product architecture, configuration design, and parametric design.**



a) Product architecture: Product architecture is concerned with **dividing the overall Design system into subsystems or modules**. In this step we decide how the physical components of the design are to be arranged and combined to carry out the functional duties of the design.

The product architecture begins to appear in the conceptual design phase from such things as diagrams of functions, rough sketches of concepts, and perhaps a proof-of-concept model. However, it is in the embodiment design phase that the layout and architecture of the product must be established by defining the basic building blocks of the product and their interfaces. a product's architecture is related to its function structure, but it does not have to match it. The physical building blocks that the product is organized into are usually called **modules**. Other terms are subsystem, subassembly, cluster, or chunk. Each module is made up of a collection of components that carry out functions. The architecture of the product is given by the relationships among the components in the product and the functions the product performs. There are two entirely opposite styles of product architecture, modular and integral.

1) **Modular architecture:** each module implements only one or a few functions, and the interactions between modules are well defined. An **EXAMPLE** would be an oscilloscope, where different measurement functions are obtained by plugging in different modules,
2) In an **integral architecture***: In* integral product architectures, components perform multiple functions. This reduces the number of components, generally decreasing cost unless the integral architecture is obtained at the expense of extreme part complexity. Integral product architecture is often adopted when constraints of weight, space, or cost make

It difficult to achieve required performance. Propose a four-step process for establishing the product Architecture.

- Create a schematic diagram of the product.
- Cluster the elements of the schematic.
- Create a rough geometric layout.
- Identify the interactions between modules.

b) Configuration design of parts and components: In configuration design we establish the shape and general dimensions of components. The term *component* is used in the generic sense to include special-purpose parts, standard parts, and standard assemblies. Configuring a part means to determine what features will be present and how those features are to be arranged in space relative to each other. While modeling and simulation may be performed in this stage to check out function and spatial constraints, only approximate sizes are determined to assure that the part satisfies the PDS. Also, more specificity about materials and manufacturing is given here. The generation of a physical model of the part with rapid prototyping processes may be appropriate.

In starting configuration design we should follow these steps:

- Review the product design specification and any specifications developed for the particular subassembly to which the component belongs.
- Establish the spatial constraints that relate to the product or the subassembly being

Designed.

- Most of these will have been set by the product architecture .In addition to physical spatial constraints, consider the constraints of a human working with the product and constraints that relate to the product’s life cycle, such as the need to provide access for maintenance or repair or to dismantle it for recycling.

- Create and refine the interfaces or connections between components.
- Again, the product architecture should give much guidance in this respect. Much design effort occurs at the connections between components, because this is the location where failure often occurs. Identify and give special attention to the interfaces that transfer the most critical functions.
- Before spending much time on the design, answer the following questions: Can the part be eliminated or combined with another part? Studies of design for manufacture (DFM) show that it is almost always less costly to make and assemble fewer, more complex parts than it is to design with a higher part count.
- Can a standard part or subassembly be used? While a standard part is generally less costly than a special-purpose part, two standard parts may not be less costly than one special-purpose part that replaces them.

Identify the likely ways the part might fail in service.

● **Excessive plastic deformation.** Size the part so that stresses are below the yield strength.

● **Fatigue failure.** If there are cyclic loads, size the part so that stresses are below the fatigue limit or fatigue strength for the expected number of cycles in service.

● **Stress concentrations**. Use generous fillets and radii so that stress raisers are kept low. This is especially important where service conditions are at risk to fatigue or brittle failure.

● **Buckling.** If buckling is possible, configure the part geometry to prevent buckling.

● **Shock or impact loads**. Be alert to this possibility, and configure the part geometry and select the material to minimize shock loading.

Identify likely ways that part functionality might be compromised.

● **Tolerances:** Are too many tight tolerances required to make the part work well? Have you checked for tolerance stack-up in assemblies?

● **Creep:** Creep is change of dimensions over time at elevated temperature. Many polymers exhibit creep above 100°C. Is creep a possibility with this part, and if so, has it been considered in the design?

● **Thermal deformation.** Check to determine whether thermal expansion or contraction could interfere with the functioning of a part or assembly.

Materials and manufacturing issues

● Is the material selected for the part the best one to prevent the likely failure modes in service?

● Is there a history of use for the material in this or similar applications?

- Can the form and features of the part be readily made on available production machines?
- Will material made to standard quality specifications be adequate for this part?
- Will the chosen material and manufacturing process meet the cost target for the part?

c) Parametric design of parts: Parametric design starts with information on the configuration of the part and aims to establish its exact dimensions and tolerances. Final decisions on the material and manufacturing processes are also established if this has not been done previously. An important aspect of parametric design is to examine the part, assembly, and system for design robustness. *Robustness* refers to how consistently a component performs under variable conditions in its service environment. *Robustness* means achieving excellent performance under the wide range of conditions that will be found in service. All products function reasonably well under ideal (laboratory) conditions, but robust designs continue to function well when the conditions to which they are exposed are far from ideal Dimensions and tolerances were set tentatively, and while analysis was used to "size the parts" it generally was not highly detailed or sophisticated. Now the design moves into parametric design, the latter part of embodiment design.

A systematic parametric design takes place in five steps

Step 1. Formulate the parametric design problem:

The designer should have a clear understanding of the function or functions that the component to be designed must deliver. This information should be traceable back to the PDS and the product architecture, but the product design specification (PDS) should be the guiding document. From this information we select the engineering characteristics that measure the predicted performance of the function. These *solution evaluation parameters* (SEPs) are often metrics like Cost, weight, efficiency, safety, and reliability. Next we identify the design variables. The *design variables* (DVs) are the parameters under the control of the designer that determine the performance of the component. Design variables most influence the dimensions, tolerances, or choice of materials for the component. The design variables should be identified with variable name, symbol, units, and upper and lower limits for the variable. Also, we make sure we understand and record the *problem definition parameters* (PDPs). These are the operational or environmental conditions under which the component or system must operate. **Examples** are loads, flow rate, and temperature increase. Finally, we develop a Plan for Solving the Problem.

This will involve some kind of analysis for stresses, or vibration, or heat transfer. In conceptual design you used elementary physics and chemistry, and a “gut feel” for whether the concept would work. In configuration design you used simple models from engineering science courses, but in parametric design you will most likely use more detailed models, including finite-element analysis on critical components. The deciding factors for the level of detail in analysis will be the time, money, and available analysis tools, and whether, given these constraints, the expected results are likely to have sufficient credibility and usefulness.

Step 2. Generate alternative designs:

Different values for the design variables are chosen to produce different candidate designs. Remember, the alternative configurations were narrowed down to a single selection in confi guration design. Now, we are determining the best dimensions or tolerances for the critical-to quality aspects of that configuration. The values of the DVs come from your or the company’s experience, or from industry standards or practice.

Step 3. Analyze the alternative designs*:*

Now we predict the performance of each of the alternative designs using either analytical or experimental methods. Each of the designs is checked to see that it satisfies every performance constraint and expectation. These designs are identified as *feasible designs.*

Step 4. Evaluate the results of the analyses.

All the feasible designs are evaluated to determine which one is best using the solution evaluation parameters. Often, a key performance characteristic is chosen as an *objective function, and* optimization methods are used to either maximize or minimize this value. Alternatively, design variables are combined in some reasonable way to give a *figure of merit,* and this value is used for deciding on the best design

Step 5. Refine/Optimize.

If none of the candidate designs are feasible designs, then it is necessary to determine a new set of designs. If feasible designs exist, it may be possible to improve their rating by changing the values of the design variables in an organized way so as to maximize or minimize the objective function.

Unit-03/Lecture-03

DETAIL DESIGN:

Detailed design is such a fundamental necessity to manufacturers that it exists at the intersection of many product development processes. And given this broad influence, as well as the impact of prevailing industry dynamics such as distributed product development, shortening product development lifecycles and increased product complexity, companies are feeling immense pressure to improve their detailed design process. Missing information is added on the arrangement, form, dimensions, and tolerances, surface properties, materials, and manufacturing processes of each part. This results in a specification for each *special-purpose part* and for each *standard part* to be purchased from suppliers. In the detail design phase the following activities are completed and documents are prepared:

Detail design

Engineering

Drawings

Finalize PDS

● Detailed engineering drawings suitable for manufacturing. Routinely these are computer-generated drawings, and they often include three-dimensional CAD models.

● Verification testing of prototypes is successfully completed and verification data is submitted. All critical-to-quality parameters are confirmed to be under control. Usually the building and testing of several preproduction versions of the product will be accomplished.

● Assembly drawings and assembly instructions also will be completed. The bill of materials for all assemblies will be completed.

● A detailed product specification, updated with all the changes made since the conceptual Design phase will be prepared.

● Decisions on whether to make each part internally or to buy from an external supplier will be made.

● With the preceding information, a detailed cost estimate for the product will be carried out.

● Finally, detail design concludes with a design review before the decision is made to pass the design information on to manufacturing.

In many engineering organizations it is no longer correct to say that detail design is the phase of design where all of the dimensions, tolerances, and details are finalized. However, detail design, as the name implies, is the phase where *all of the details are brought together, all decisions are Finalized,* and a decision is made by management to release the design for production. Poor detail design can ruin a brilliant design concept and lead to manufacturing defects, high costs, and poor reliability in service.

ACTIVITIES AND DECISIONS IN DETAIL DESIGN:

1) Make/buy decision: Even before the design of all components is completed and the drawings finalized, meetings are held on deciding whether to make a component in-house or to buy it from an external supplier. This decision will be made chiefly on the basis of cost and manufacturing capacity, with due consideration given to issues of quality and reliability of delivery of components An important reason for making this decision early is so you can bring the supplier into the design effort as an extended team member.

2) Complete the selection and sizing of components

While most of the selection and sizing of components occurs in embodiment design, especially for those components with parameters deemed to be critical-to-quality, some components may not yet have been selected or designed. These may be standard components that will be purchased from external suppliers or routine standard parts like fasteners. Or, there may be a critical component for which you have been waiting for test data or FEA analysis results. Regardless of the reason, it is necessary to complete these activities before the design can be complete.

3) Complete engineering drawings: A major task in the detail design phase is to complete the engineering drawings. As each component, subassembly, and assembly is designed, it is documented completely with drawings. Drawings of individual parts are usually called *detail Drawings* .These shows the geometric features, dimensions, and tolerances of the parts.

4) Revise the product design specification: We need to distinguish between the part specification and the product design specification. For individual parts the drawing and the specification are often the same document. The specification contains information on the technical performance of the part, its dimensions, test requirements, materials requirements, reliability requirement, design life, packaging requirement, and marking for shipment. The part Specification should be sufficiently detailed to avoid confusion as to what is expected from the supplier.

5) Complete verification prototype testing: Once the design is finalized, a beta-prototype is built and verification tested to ensure that the design meets the PDS and that it is safe and reliable. that beta-prototypes are made with the same materials and manufacturing processes as the product but not necessarily from the actual production line. Later, before product launch, actual products from the production line will be tested. Depending on the complexity of the product, the verification testing may simply be to run the product during an expected duty cycle and under overload conditions, or it may be a series of statistically planned tests.

6) Final cost estimate: The detail drawings allow the determination of final cost estimates, since knowledge of the material, the dimensions, tolerances, and finish of each part are needed to determine manufacturing cost.

7) **Prepare design project report:** A design project report usually is written at the conclusion of a project to describe the tasks undertaken and to discuss the design in detail. Also, a design project report may be an important document if the product becomes involved in either product liability or patent litigation.

8) Final design review: Many formal meetings or reviews will have preceded the fi nal design review. These include an initial product concept meeting to begin the establishment of the PDS The latter may take the form of detailed partial reviews (meetings) to decide important issues like design for manufacturing, quality issues, reliability, safety, or preliminary cost estimates

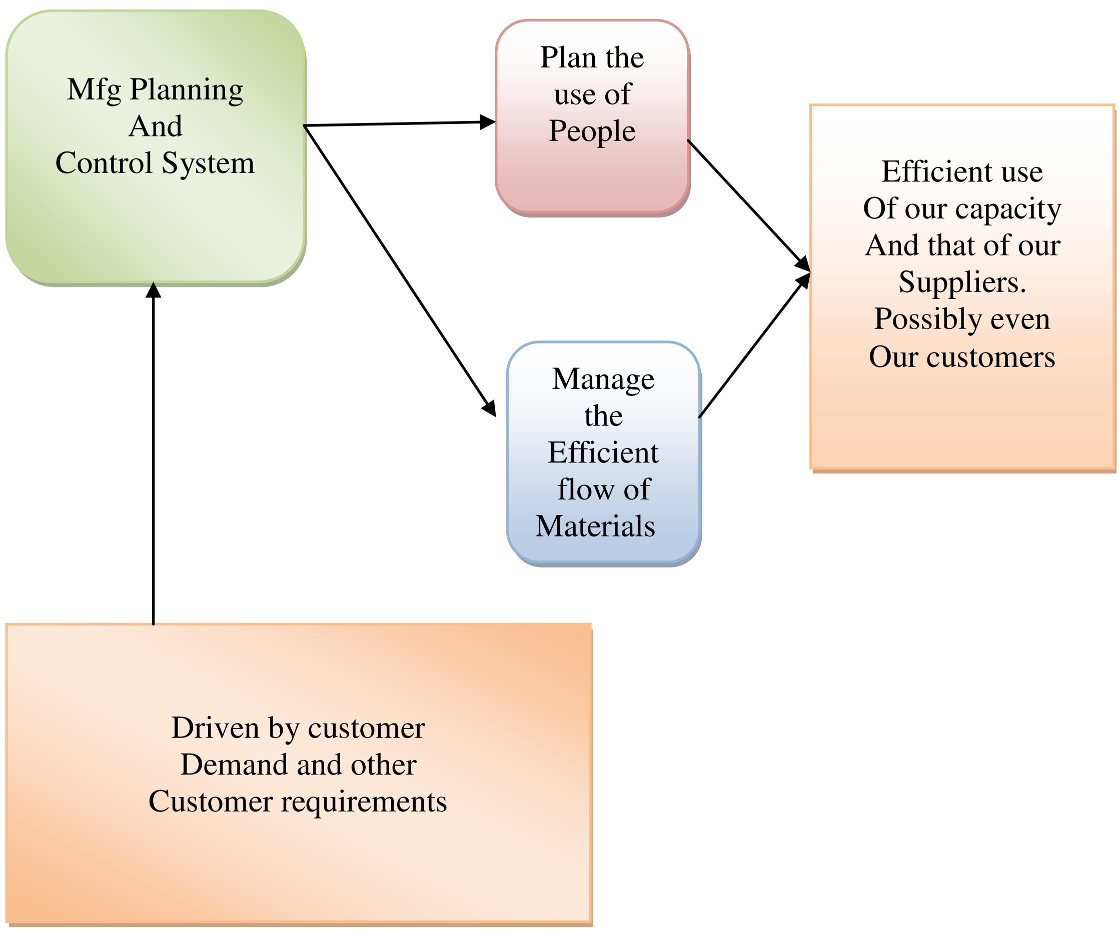
9) Release design to manufacturing: The release of the product design to manufacturing ends the main activity of the design personnel on that product. The increasing use of the concurrent engineering approach to minimize the product development time blurs the boundary between detail design and manufacturing. It is common to release the design to manufacturing in two
Or three "waves," with those designs that have the longest lead time for designing and making tooling being released first.

Unit-03/Lecture-04

Planning for Production/ Manufacturing

A Manufacturing Planning and Control system is a methodology designed to manage efficiently the flow of material, the utilization of people and equipment, and to respond to customer requirements by utilizing the capacity of our suppliers, that of our internal facilities, and in some cases that of our customers to meet customer demand. A new battery of skills, those of tool design and production engineering, come into play.

Producing the design is a critical link in the chain of events that starts with a creative idea and ends with a successful product in the marketplace. The term **materials processing** to refer to the conversion of semi finished products focus on improving the link between manufacturing and design has increased emphasis on codifying a set of practices that designers should follow to make their designs easier to manufacture, **design for manufacture (DFM),** the level of confidence in the success of product must be very high to support a positive decision. The decision must be made at the top level of management. Different types of production methods, such as single item manufacturing, **batch production, mass production, continuous production etc. have their own type of production planning.**



The process must be selected in such a way that the produced product will be acceptable to the consumer functionally, economically and appearance-wise.

A great deal of detailed planning must be done to provide for the production of the design. A method of manufacture must be established for each component in the system. As a usual first step, a *process sheet* is created; it contains a sequential list of all manufacturing operations that must be performed on the component. Also, it specifies the form and condition of the material and the tooling and production machines that will be used. The information on the process sheet makes possible the estimation of the production cost of the component. High costs may indicate the need for a change in material or a basic change in the design. Close interaction with manufacturing, industrial, materials, and mechanical engineers is important at this step.

The other important tasks performed in phase IV are the following:

i) Detail process planning: is requiring for every part, subassembly, and final assembly. The information is usually displayed on process sheets, one for each part of subassembly. The process sheet contains a sequential list of operations which must be performed to produce a part .it specifies raw material, clarify special instructions and indicates machines and tools required .such difficulty can be minimized earlier by timely consultations between product designers and tool designers.

ii) Designing specialized tools and **fixtures(fittings)**

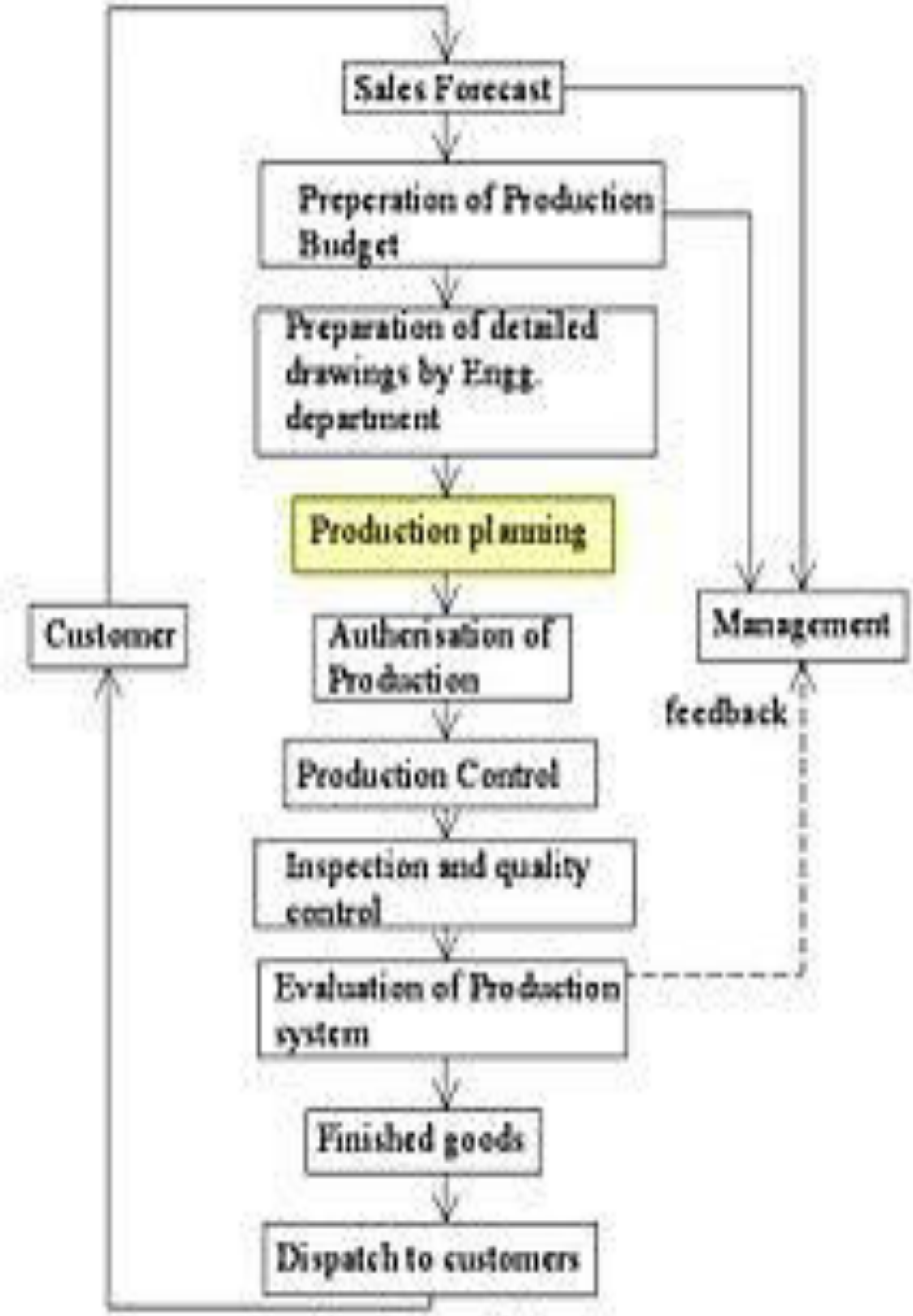
iii) Specifying the production plant that will be used (or designing a new plant) and
laying out the production lines

iv)Planning for production control: Planning the work schedules and inventory controls (production control)

v) Planning the quality assurance system

vi) Planning for production personnel: Establishing the standard time and labor costs for each operation

vii) Planning for information flow system: Establishing the system of information flow necessary to control the manufacturing Operation. Flow patterns and routines are established



Production Cycle

PLANNING FOR DISTRIBUTION:

Effective planning of transportation and distribution networks has become more complex. This is driven by increasing customer requirements, expansion of global sourcing, security and regulatory requirements, volatile fuel costs, etc. Important technical and business decisions must be made to provide for the effective distribution to the consumer of the products that have been produced. A system of warehouses for distributing the product may have to be designed if none exists. The economic success of the design often depends on the skill exercised in marketing the product. If it is a consumer product, the sales effort is concentrated on advertising in print and video media, but highly technical products may require that the marketing step be a technical activity supported by specialized sales brochures, performance test data, and technically trained sales engineers. Over the last few years, the demand placed on the distribution and logistics departments of manufacturing and marketing organizations has been continuously intensifying due to pressures from increased competition, introduction of new manufacturing methods, and increased expectations from partners and consumers in terms of low price and high service levels. Corporations are looking to **increase their customer service levels, while reducing inventory, working capital requirements and distribution costs.**

Distribution involves a number of activities centred on a physical flow of goods and information. At one time the term distribution applied only to the outbound side of supply chain management, but it now includes both inbound and outbound.

Management of the inbound flow involves these elements:

- Material planning and control
- Purchasing
- Receiving
- Physical management of materials via warehousing and storage
- Materials handling

Management of the outbound flow involves these elements:

- Order processing
- Warehousing and storage
- Finished goods management
- Material handling and packaging
- Shipping

- Transportation

Distribution channels are formed to solve three critical distribution problems: functional performance, reduced complexity, and specialization. The central focus of distribution is to increase the efficiency of time, place, and delivery utility.

ROLE OF THE DISTRIBUTION FUNCTION

There are a number of critical functions performed by the channel distributor.

1. **Product acquisition (purchasing).** This means acquiring products in a finished or semi-finished state from either a manufacturer or through another distributor that is higher up in the supply channel. These functions can be performed by independent channel intermediaries or by the distribution facilities of manufacturing companies.
2. **Product movement:** This implies significant effort spent on product movement up or down the supply channel.
3. **Product transaction:** Distributors can be characterized as selling products in bulk quantities solely for the purpose of resale or business use. Downstream businesses will then sell these products to other distributors or retailers who will sell them directly to the end customer, or to manufacturers who will consume the material/components in their own production processes.

Following are the separate elements contained within the three critical functions of distribution:

- **Selling and promoting**. This function is very important to manufacturers. One strategy involves the use of distribution channels to carry out the responsibilities of product deployment. In addition to being marketing experts in their industry, distribution firms usually have direct-selling organizations and a detailed knowledge of their customers and their expectations. The manufacturer utilizing this distributor can then tap into these resources. Also, because of the scale of the distributing firm's operations and its specialized skill in channel management, it can significantly improve the time, place, and possession utilities by housing inventory closer to the market. These advantages mean that the manufacturer can reach many small, distant customers at a relatively low cost, thus allowing the manufacturer to focus its expenditures on product development and its core production processes.

- **Buying and building product assortment (range)**. This is an extremely important function for retailers. Most retailers prefer to deal with few suppliers providing a wide assortment of products that fit their merchandizing strategy rather than many with limited product lines. This, of course, saves on purchasing, transportation, and merchandizing costs. Distribution firms have the ability to bring together related products from multiple manufacturers and assemble the right combination of these products in quantities that meet the retailer's requirements in a cost-efficient manner.
- **Bulk breaking.** This is one of the fundamental functions of distribution. Manufacturers normally produce large quantities of a limited number of products. However, retailers normally require smaller quantities of multiple products. When the distribution function handles this requirement it keeps the manufacturer from having to break bulk and repackage its product to fit individual requirements. Lean manufacturing and JIT techniques are continuously seeking ways to reduce lot sizes, so this function enhances that goal.
- **Value-added processing.** Postponement specifies that products should be kept at the highest possible level in the pipeline in large, generic quantities that can be customized into their final form as close as possible to the actual final sale. The distributor can facilitate this process by performing sorting, labelling, blending, kitting, packaging, and light final assembly at one or more points within the supply channel. This significantly reduces end-product obsolescence and minimizes the risk inherent with carrying finished goods inventory.
- **Transportation**. The movement of goods from the manufacturer to the retailer is a critical function of distribution. Delivery encompasses those activities that are necessary to ensure that the right product is available to the customer at the right time and right place. This frequently means that a structure of central, branch, and field warehouses, geographically situated in the appropriate locations, are needed to achieve optimum customer service. Transportation's goal is to ensure that goods are positioned properly in the channel in a quick, cost-effective, and consistent manner.
- **Warehousing.** Warehousing exists to provide access to sufficient stock in order to satisfy anticipated customer requirements, and to act as a buffer against supply and demand uncertainties. Since demand is often located far from the source (manufacturer), warehousing can provide a wide range of marketplaces that manufacturers, functioning independently, could not penetrate.
- **Marketing information.** The distribution channel also can provide information

regarding product, marketplace issues, and competitors' activities in a relatively short time.

Distribution Planning systems can address the following operational issues faced by a supply chain manager

- **Product dispatching**: When and where should a product be dispatched?
- **Product placement**: Which product should be held at each location and in what quantity?
- **Transportation loading**: What products should be loaded on to a vehicle?
- **Transportation choice**: Which mode of transportation should be used?
- **Transportation planning**: How many vehicles of each type would be required on what days in the next one month?

Requirements of a good distribution planning system

1. **Minimize total cost** of distribution
2. **Increase manager productivity** through automated, high-speed planning
3. **Formalize informed decision-making** and reduce variability in the Distribution planning process
4. **Improve information visibility and coordination** between Marketing, Distribution and Production.
5. **Improve responsiveness** by

   a) Allowing planners to **quickly adjust** production and distribution plans to demand/supply variability (for example, changes in demand forecasts, supply delays, etc.)

   b) Generating production and distribution requirements for different demand and supply scenarios, allowing for **contingency planning**

Unit-03/Lecture-06

PLANNING FOR CONSUMPTION:

Consumption is the sixth phase of morphological design, as a process it occurs naturally after distribution. Its influence on design is thoughtful because it pass through all phases.therfore it is for the most important diffused phase concerned with consumer needs and utility,and mingled and attached to the earlier phases The use of the product by the consumer is all-important, and considerations of how the consumer will react to the product pervade all steps of the design process. The following specific topics can be identified as being important user-oriented concerns in the design process: ease of maintenance, durability, reliability, product safety, and convenience in use (human factors engineering), aesthetic appeal, and economy of operation. Obviously, these consumer-oriented issues must be considered in the design process at its very beginning. They are not issues to be treated as afterthoughts. Phase VI of design is less well defined than the others, but it is becoming increasingly important with the growing concerns for consumer protection and product Safety. More strict interpretation of product liability laws is having a major impact on design. An important phase VI activity is the acquisition of reliable data on failures, service lives, and consumer complaints and attitudes to provide a basis for product improvement in the next design cycle. The purpose of this phase is to incorporate in the design ,adequate service features and to provide a rational basis for product improvement and redesign

Design for consumption must consider the following factors:

i) Design for maintenance

ii) Design for reliability

iii)Design for safety

iv)Design for convenience in use

v)Design for aesthetic features

vi)Design for operational economy

vii) Design for adequate duration of services

Unit-03/Lecture-07

Planning for Retirement:

The final step in the design process is the disposal of the retired product when it has reached the end of its useful life. Useful life may be determined by actual deterioration and wear to the point at which the design can no longer function, or it may be determined by technological obsolescence, in which a competing design performs the product's functions either better or cheaper. In consumer products, it may come about through changes in fashion or taste. In the past, little attention has been given in the design process to product retirement. This is rapidly changing, as people the world over are becoming concerned about environmental issues. There is concern with depletion of mineral and energy resources, and with pollution of the air, water, and land as a result of manufacturing and technology advancement. This has led to a formal area of study called industrial ecology. ***Design for the environment,*** also called green design, has become an important consideration in design. As a result, the design of a product should include a plan for either its disposal in an environmentally safe way or, better, the recycling of its materials or the remanufacture or reuse of its components.

When determine as to when an economic commodity in use has reached an age at which it should be retired, the point at which it can no longer render adequate service, then the need for replacement is clear because of either technical obsolescence or physical deterioration

Designing for retirement of product must consider the following aspects:

1)designing to reduce the rate of obsolescence
2)design for physical life
3)design for reusable materials and long lived component can be recovered
4)examine the service terminated products in laboratory to obtain useful design information

Example: the destruction of a tall building closely surrounded by buildings on either side. Sometimes the impact on the new design is more immediate as when an old structure or system must be replaced by new one with minimum disruption of normal operations