MP482
PRODUCT DEVELOPMENT AND DESIGN

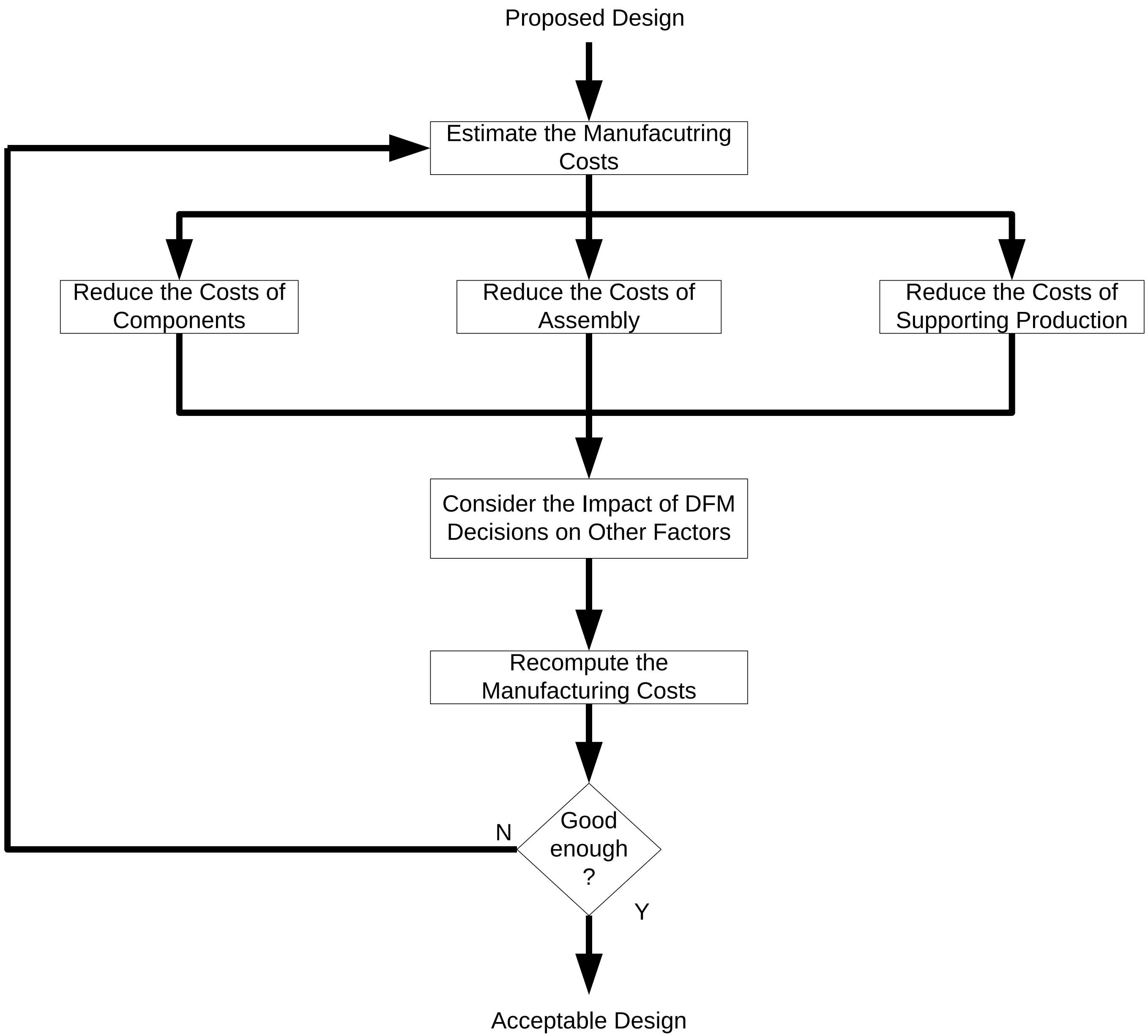
MODULE III

- Design for Manufacturing and Assembly: Methods of designing for Manufacturing and Assembly
- Designs for Maintainability.
- Designs for Environment.
- Product costing.
- Ethics in product design, legal factors and social issues.

Design for Manufacturing and Assembly

- Design for manufacturing (DFM) is design based on minimizing the cost of production and/or time to market for a product, while maintaining an appropriate level of quality.
- The strategy in DFM involves minimizing the number of parts in a product and selecting the appropriate manufacturing process.
- DFM and DFA starts with the formation of the design team which tends to be multi-disciplinary, including engineers, manufacturing managers, cost accountants, and marketing and sales professionals.

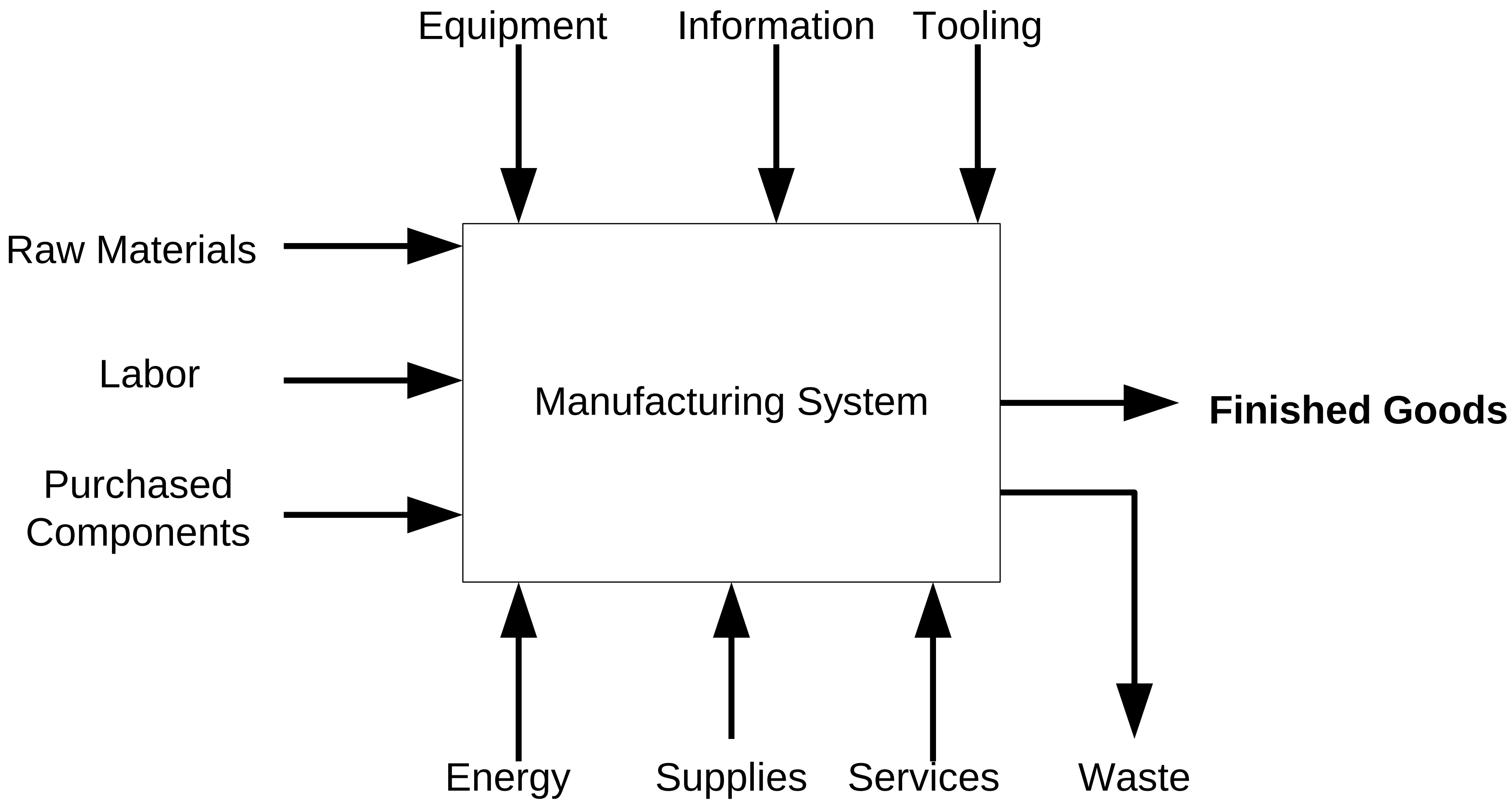
DFM Method


Proposed Design
Estimate the Manufacutring Costs
Reduce the Costs of Components
Reduce the Costs of Assembly
Reduce the Costs of Supporting Production
Consider the Impact of DFM Decisions on Other Factors
Recompute the Manufacturing Costs
Good enough ?
N
Y
Acceptable Design

DFM Method

- Estimate the manufacturing costs.
- Reduce the costs of components.
- Reduce the costs of assembly.
- Reduce the costs of supporting production.
- Consider the impact of DFM decisions on other factors.

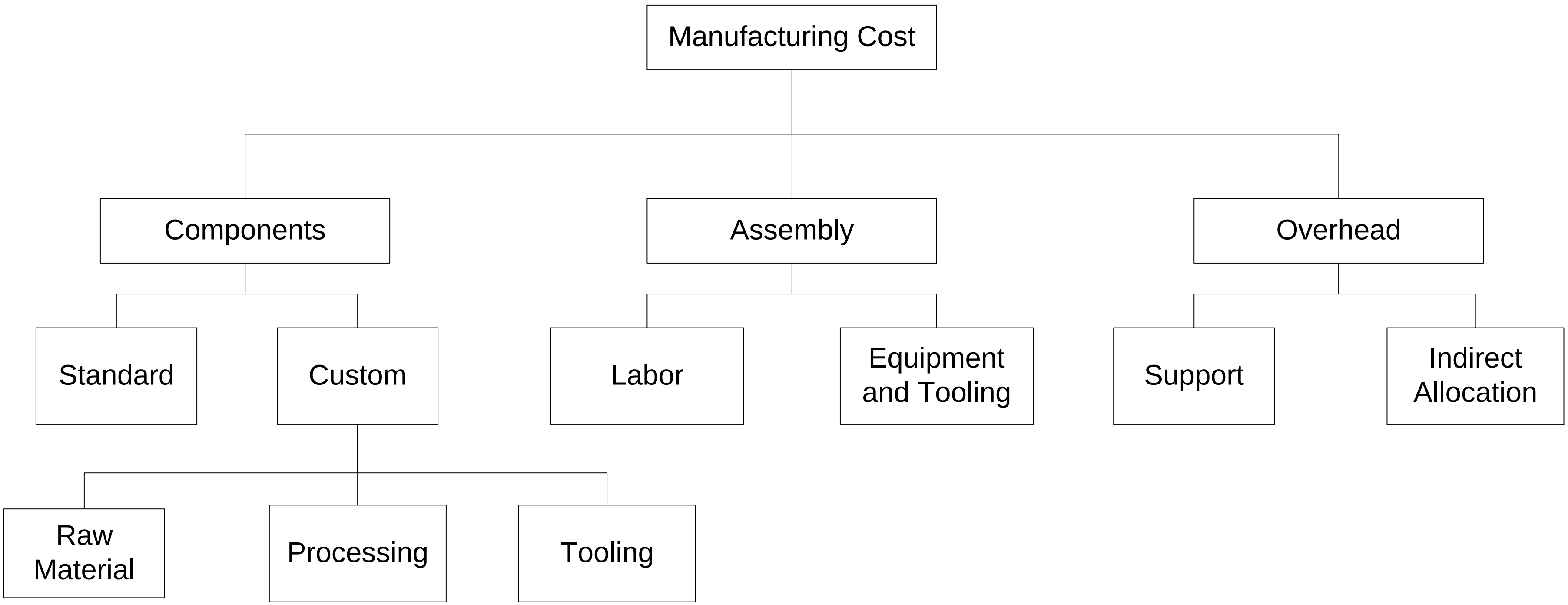
Estimate the Manufacturing Costs



Manufacturing Costs Defined

- Sum of all the expenditures for the inputs of the system (i.e. purchased components, energy, raw materials, etc.) and for disposal of the wastes produced by the system
- *Unit manufacturing cost*, which is computed by dividing the total manufacturing costs for some period (usually a quarter or a year) by the number of units of the product manufactured during that period.

Elements of the Manufacturing Cost of a Product

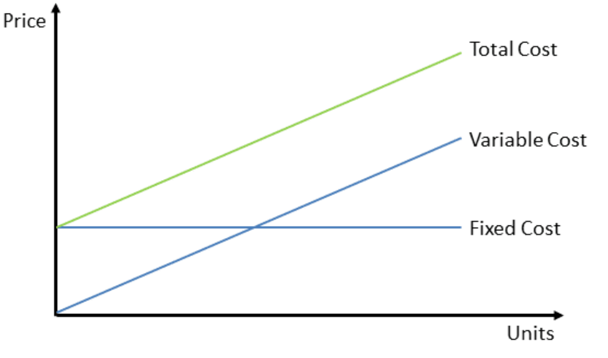


Manufacturing Cost of a Product

- Component Costs (parts of the product)
  - Parts purchased from supplier
  - Custom parts made in the manufacturer's own plant or by suppliers according to the manufacturer's design specifications
- Assembly Costs (labor, equipment, & tooling)
- Overhead Costs (all other costs)
  - Support Costs (material handling, quality assurance, purchasing, shipping, receiving, facilities, etc.)
  - Indirect Allocations (not directly linked to a particular product but must be paid for to be in business)

Fixed Costs vs. Variable Costs

- Fixed Costs – incurred in a predetermined amount, regardless of number of units produced (i.e. setting up the factory work area or cost of an injection mold)
- Variable Costs – incurred in direct proportion to the number of units produced (i.e. cost of raw materials)



Reduce the Cost of Components

- Understand the Process Constraints and Cost Drivers
- Redesign Components to Eliminate Processing Steps
- Choose the Appropriate Economic Scale for the Part Process
- Standardize Components and Processes
  - Internal Standardization and External Standardization
- Adhere to “Black Box” Component Procurement

Understand the Process Constraints and Cost Drivers

Redesign costly parts with the same performance while avoiding high manufacturing costs.

Work closely with design engineers—raise awareness of difficult operations and high costs.

Redesign Components to Eliminate Processing Steps

- Reduce the number of steps of the production process
  - Will usually result in reduce costs
- Eliminate unnecessary steps.
- Use substitution steps, where applicable.
- Analysis Tool – Process Flow Chart and Value Stream Mapping

Choose the Appropriate Economic Scale for the Part Process

Economies of Scale – As production volume increases, manufacturing costs usually decrease.

- Fixed costs divided among more units.
- Variable costs are lower since the firm can use more efficient processes and equipment.

Standardize Components and Processes

- Economies of Scale – The unit cost of a component decreases as the production volume increases.
- Standard Components—common to more than one product
- Analysis tools – group technology and mass customization

Adhere to “Black Box” Component Procurement

- Black box—only give a description of what the component has to do, not how to achieve it
- Successful black box design requires clear definitions of the functions, interfaces, and interactions of each component.

Reduce the Costs of Assembly

- Design for Assembly (DFA) index
- Integrated Parts
- Maximize Ease of Assembly
- Consider Customer Assembly

DFA Systems

- *Design for assembly* (DFA) is a fairly well-established subset of DFM that involves minimizing the cost of assembly.

Design for Assembly Index

$$\text{DFA index} = \frac{\text{(Theoretical minimum number of parts) x (3 seconds)}}{\text{Estimated total assembly time}}$$

The “3 seconds” in the numerator reflects the theoretical minimum time required to handle and insert a part that is perfectly suited for assembly.

Integrated Parts

Advantages

- Do not have to be assembled
- Often less expensive to fabricate rather than the sum of each individual part
- Allows critical geometric features to be controlled by the part fabrication process versus a similar assembly process

Maximize Ease of Assembly

- Part is inserted from the top of the assembly
- Part is self-aligning
- Part does not need to be oriented
- Part requires only one hand for assembly
- Part requires no tools
- Part is assembled in a single, linear motion
- Part is secured immediately upon insertion

Consider Customer Assembly

- Customers will tolerate some assembly
- Design product so that customers can easily and assemble correctly
- Customers will likely ignore directions

Reduce the Costs of Supporting Production

- Minimize Systemic Complexity (inputs, outputs, and transforming processes)
- Error Proofing (Poka Yoke)
  - Anticipate possible failure modes
  - Take appropriate corrective actions in the early stages
  - Use color coding to easily identify similar looking, but different parts

Consider the Impact of DFM Decisions on Other Factors

- Development Time
- Development Cost
- Product Quality
- External Factors
  - Component reuse
  - Life cycle costs

Guideline for DFM

- Reduce the number of parts in design
- Develop the product with modular design
- Design for error proofing
- Design for intended orientation and handling
- Provide simple patterns and fastening
- Use common standard parts
- Design parts for multiple use
- Consider company's production system, capabilities,limitations and regulations
- Design for verifiability
- Provide tolerance judiciously
- Incorporate robustness
- Develop the product with modular design

Guidelines for DFA

- Minimise number of parts
- Choose mode of assembly
- Encourage modular assembly
- Stack assemblies
- Eliminate adjustments
- Eliminate non value added process
- Use self fastening
- Maximize compliance
- Minimize handling
- Facilitate parts handling
- Use standard parts

Design For Environment

- Design for Environment (DFE) is a method to minimize or eliminate environmental impacts of a product over its life cycle.

- Effective DFE practice maintains or improves product quality and cost while reducing environmental impacts.

Herman Miller
Setu Multipurpose Chair

- Environmentally friendly and non-toxic materials
  - 41% aluminum, 41% polypropylene, 18% steel, by weight
- Use of recycled materials
  - 44% by weight - 23% post-consumer, 21% post-industrial
- Less material content
  - 20 lbs lighter than most task chairs
- Easy to disassemble
  - 86% easily separable materials
- Recyclable
  - 92% by weight
- Production line uses 100% green power
- No air or water emissions released in production
- Returnable and recyclable packaging

Source: Herman Miller, Inc.

HermanMiller

Environmental Impacts

Global Warming

Resource depletion

Solid waste

Water pollution

Air pollution

Land degradation

www.buildbabybuild.com

www.co.rockingham.nc.us

www.flickr.com Ben Rad

commons.wikimedia.org

www.wonkroom.thinkprogress.org

www.adb.org

Environmental Impacts

Global warming:

- the temperature of the earth is gradually increasing as a result of the accumulation of greenhouse gases, particulates, and water vapor in the upper atmosphere.
- This effect appears to be accelerating as a result of emissions of carbon dioxide (CO2), methane (CH4), chlorofluorocarbons (CFCs), black carbon particles, and nitrogen oxides (NOx) from industrial processes and products.

Resource depletion:

- Many of the raw materials used for production, such as iron ore, gas, oil, and coal, are nonrenewable and supplies are limited.

Solid waste:

- Products may generate solid waste throughout their life cycle. Some of this waste is recycled, but most is disposed in incinerators or landfills. Incinerators
- generate air pollution and toxic ash (which goes into landfills).
- Landfills may also create concentrations of toxic substances, generate methane gas (CH4), and release groundwater pollutants.

Environmental Impacts

Water pollution:

- The most common sources of water pollution are discharges from industrial processes, which may include heavy metals, fertilizers, solvents, oils, synthetic substances, acids, and suspended solids.

Air pollution:

- Sources of air pollution include emissions from factories, power generating plants, incinerators, residential and commercial buildings, and motor vehicles. Typical pollutants include CO2, NOx, sulfur dioxide (SO2), ozone (O3), and volatile organic compounds (VOCs).

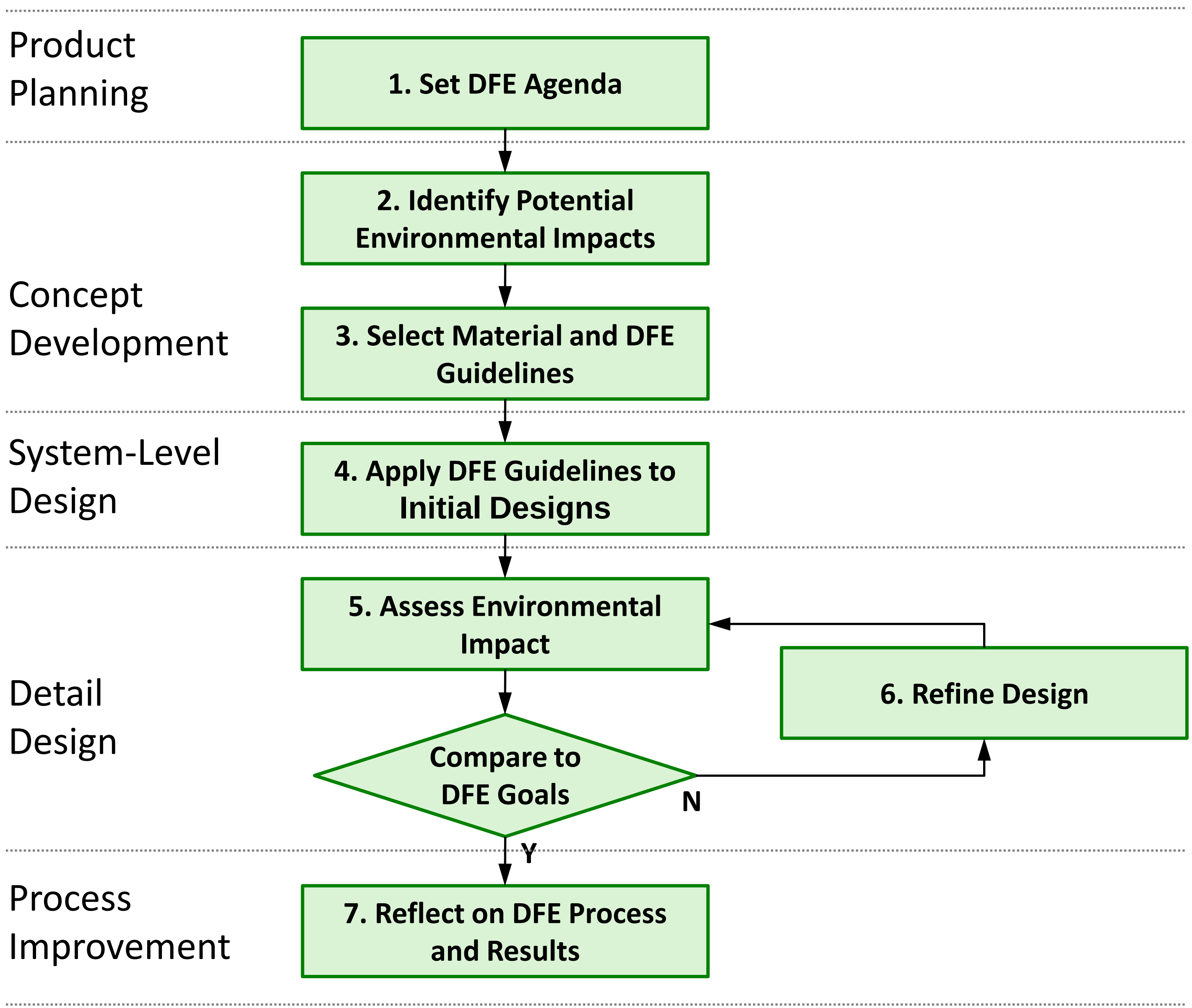
Land degradation:

- Land degradation concerns the adverse effects that raw material extraction and production, such as mining, farming, and forestry, have on the environment.

Ozone depletion:

- The ozone layer protects the earth against the harmful effects of the sun’s radiation. It is degraded by reactions with nitric acid (created by the burning of fossil fuels) and chorine compounds (such as CFCs).

DFE Process


Product Planning
1. Set DFE Agenda
2. Identify Potential Environmental Impacts
Concept Development
3. Select Material and DFE Guidelines
System-Level Design
4. Apply DFE Guidelines to Initial Designs
5. Assess Environmental Impact
6. Refine Design
Detail Design
Compare to DFE Goals
N
Y
Process Improvement
7. Reflect on DFE Process and Results

Step 1: Set the DFE Agenda: Drivers, Goals, and Team

- Consists of three activities:
  - Identifying the internal and external drivers of DFE,
  - setting the environmental goals for the product,
  - setting up the DFE team.

Step 1: Set the DFE Agenda: Drivers, Goals, and Team

- Identify the Internal and External Drivers of DFE
- Internal drivers are the DFE objectives within the organization.
- ***Product quality:***
  - A focus on environmental performance may raise the quality of the product in terms of functionality, reliability in operation, durability, and repairability.
- ***Public image:***
  - Communicating a high level of environmental quality of a product can improve a company’s image.
- ***Cost reduction:***
  - Using less material and less energy in production can result in considerable cost savings. Generating less waste and eliminating hazardous waste results in lower waste disposal costs.
- ***Innovation:***
  - Sustainable thinking can lead to radical changes in product design and may foster innovation across the whole company.

Step 1: Set the DFE Agenda: Drivers, Goals, and Team

- ***Operational safety:***
  - By eliminating toxic materials, many DFE changes can help improve the occupational health and safety of employees.
- ***Employee motivation:***
  - Employees can be motivated to contribute in new and creative ways if they are able to help reduce the environmental impacts of the company’s products and operations.
- ***Ethical responsibility:*** I
  - Interest in sustainable development among managers and product developers may be motivated in part by a moral sense of responsibility for conserving the environment and nature.
- ***Consumer behavior:***
  - Wider availability of products with positive environmental benefits may accelerate the transition to cleaner lifestyles and demand for greener products.

Step 1: Set the DFE Agenda: Drivers, Goals, and Team

- External drivers are the DFE objectives within the organization
- ***Environmental legislation:***
  - Product-oriented environmental policy is developing rapidly.
- ***Market demand:***
  - Today, companies operate in a business environment of increasingly well-informed industrial customers and end users who may demand sustainable products.
  - Negative publicity, blogs, and boycotts of products, manufacturers, or retailers can have considerable impact on sales.
  - Of course, the opposite positive effect is becoming more powerful as well

Step 1: Set the DFE Agenda: Drivers, Goals, and Team

- ***Competition:***
  - Sustainability activities undertaken by competitors can lead to pressure for more emphasis on DFE.
- ***Trade organizations:***
  - Trade or industrial organizations in some branches of industry— such as packaging and automobile manufacturing—encourage companies to take environmental action by sharing technology and establishing codes of conduct.
- ***Suppliers:***
  - Suppliers influence company behavior by introducing more sustainable materials and processes. Companies may choose to audit and confirm environmental declarations of their suppliers.
- ***Social pressures:***
  - Through their social and community contacts, managers and employees may be asked about the responsibility that their business takes for the environment.

Step 1: Set the DFE Agenda: Drivers, Goals, and Team

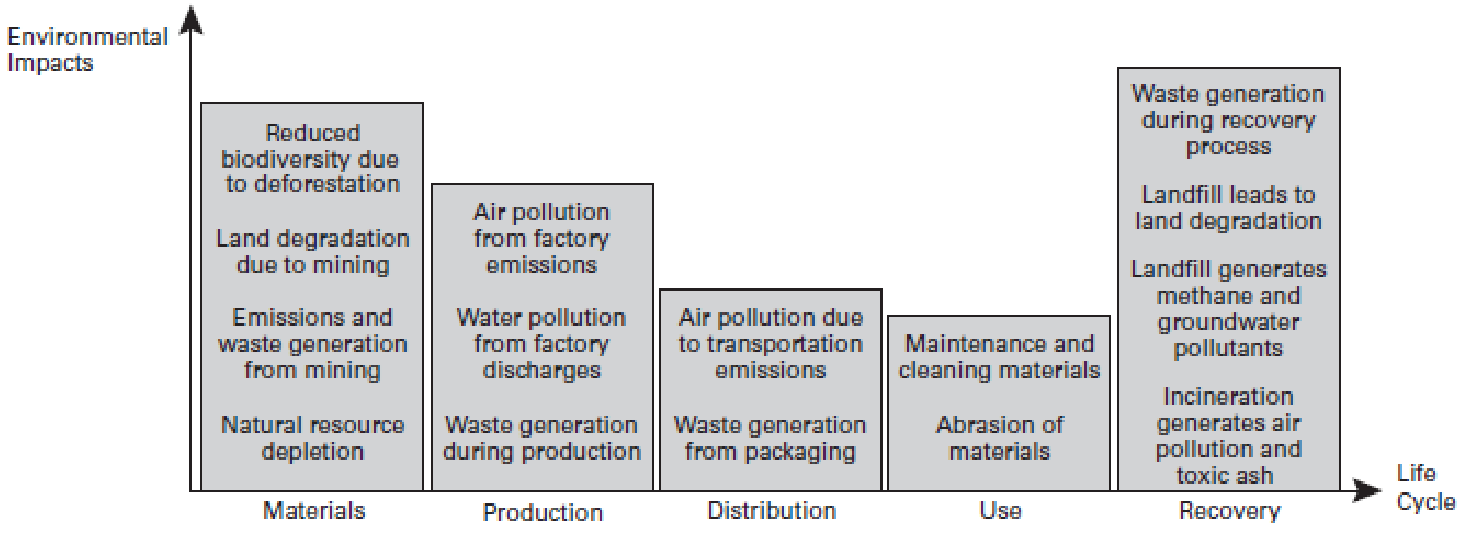
- Set the DFE Goals
  - An important activity in the product planning phase is to set the environmental goals for each product development project.
  - These goals define how the organization complies with environmental regulations and how the organization reduces the environmental
  - Eg of DFE goals: Use renewable materials,Avoid toxic materials,Facilitate material recycling

Step 1: Set the DFE Agenda: Drivers, Goals, and Team

- SET DFE TEAM
  - DFE requires participation by many functional experts on the product development project.
  - The typical composition of a DFE team (often a subteam within the overall project team) consists of a DFE leader, an environmental chemistry and materials expert, a manufacturing engineer, and a representative from the purchasing and supply chain organization.
  - Of course, the DFE team composition depends on the organization and needs of the specific project, and may also include marketing professionals, outside consultants, suppliers, or other experts.

Step 2:Identify Potential Environmental Impacts

- The team lists for each life cycle stage the anticipated key environmental impacts.
- The height of each bar in the chart represents the team's judgment about the overall magnitude of the potential environmental impacts and therefore where to focus their DFE efforts.



Step 3: Select DFE Guidelines

- Guidelines help product design teams to make early DFE decisions without the type of detailed environmental impact analysis that is only possible after the design is more fully specified.
- Relevant guidelines may be selected based in part on the qualitative assessment of life cycle impacts (from step 2).
- Selecting relevant guidelines during the concept development phase allows the product development team to apply them throughout the product development project.

DFE and Material Guidelines

Example DFE Guidelines

- Do not combine materials incompatible in recycling
- Label all component materials for recycling
- Enable easy disassembly into separate material recycling streams
- Use no surface treatments
- Eliminate packaging
- Reduce weight and size for shipping

Example Material Guidelines

- Use recycled and recyclable industrial materials
- Use natural materials which can be returned to biological decay cycles
- Use processes which do not release toxic materials
- Capture and reuse all hazardous materials

Step 4: Apply the DFE Guidelines to the Initial Product Design

- As the product architecture is developed during the system-level design phase , some initial material choices are made along with some of the module design decisions.
- In the detail-design phase, the exact materials specifications, detailed geometry, and manufacturing processes are determined.
- By specifying low-impact materials and reducing energy consumption, product development teams create more environmentally friendly products.
- Furthermore, the DFE guidelines may inspire product development teams to come up with improvement in the functionality and durability of the product, which may lead to significant lower environmental impacts

Step 5: Assess the Environmental Impacts

- The next step is to assess, to the extent possible, the environmental impacts of the product over its entire life cycle.
- To do so with precision requires a detailed understanding of how the product is to be produced, distributed, used over its lifetime, and recycled or disposed at the end of its useful life.
- This assessment is generally done on the basis of the detailed bill of materials (BOM), including sources of energy, component material specifications, suppliers, transportation modes, waste streams, recycling methods, and disposal means.
- Several quantitative life cycle assessment (LCA) tools are available to conduct such an environmental assessment.

Step 6: Refine the Product Design to Reduce or Eliminate the Environmental Impacts

- The objective of this step and subsequent DFE iterations is to reduce or eliminate any significant environmental impacts through redesign.
- The process repeats until the environmental impacts have been reduced to an acceptable level and the environmental performance fits the DFE goals.
- Redesign for ongoing improvement of DFE may also continue after production begins.

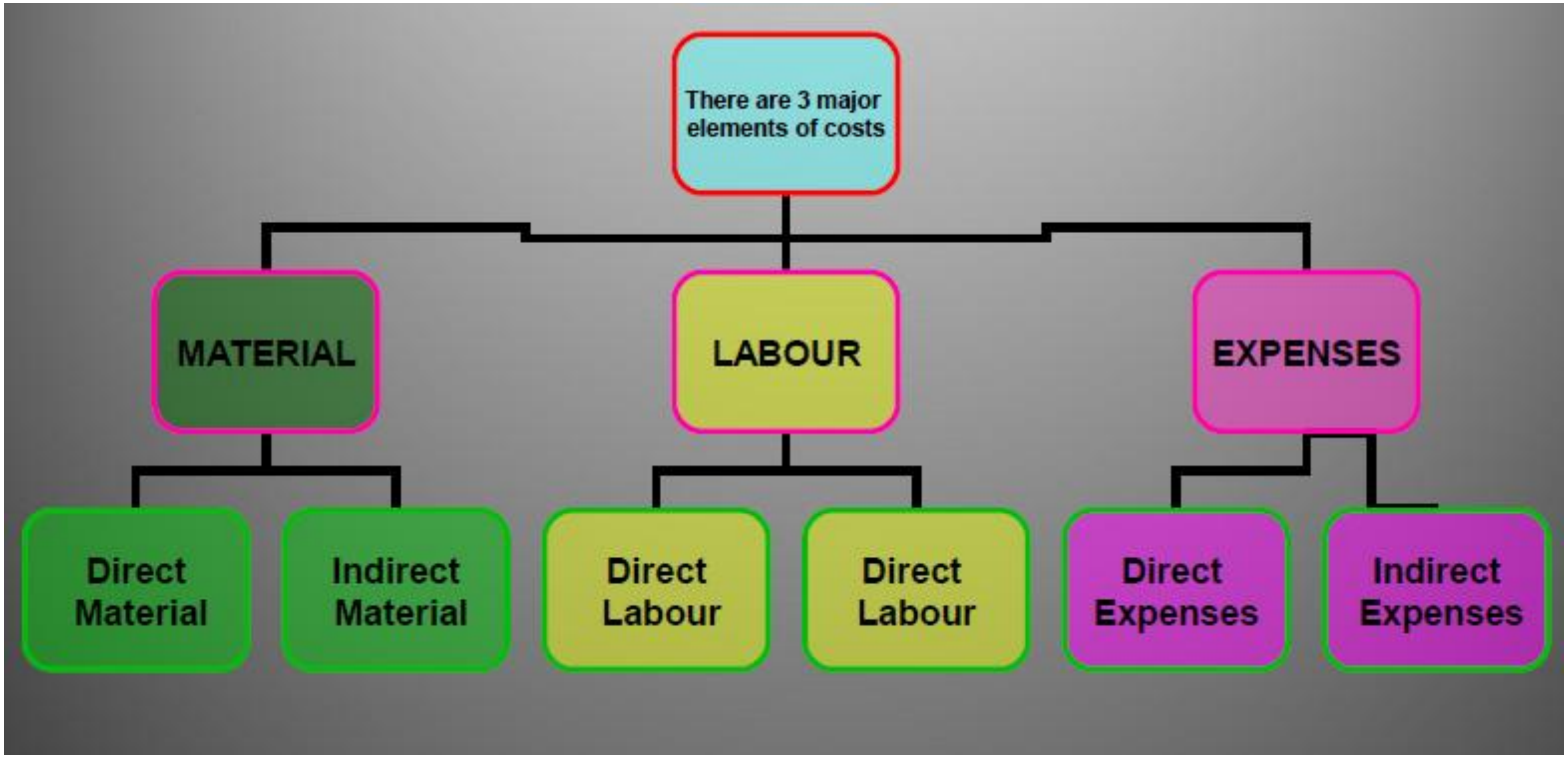
Step 7: Reflect on the DFE Process and Results

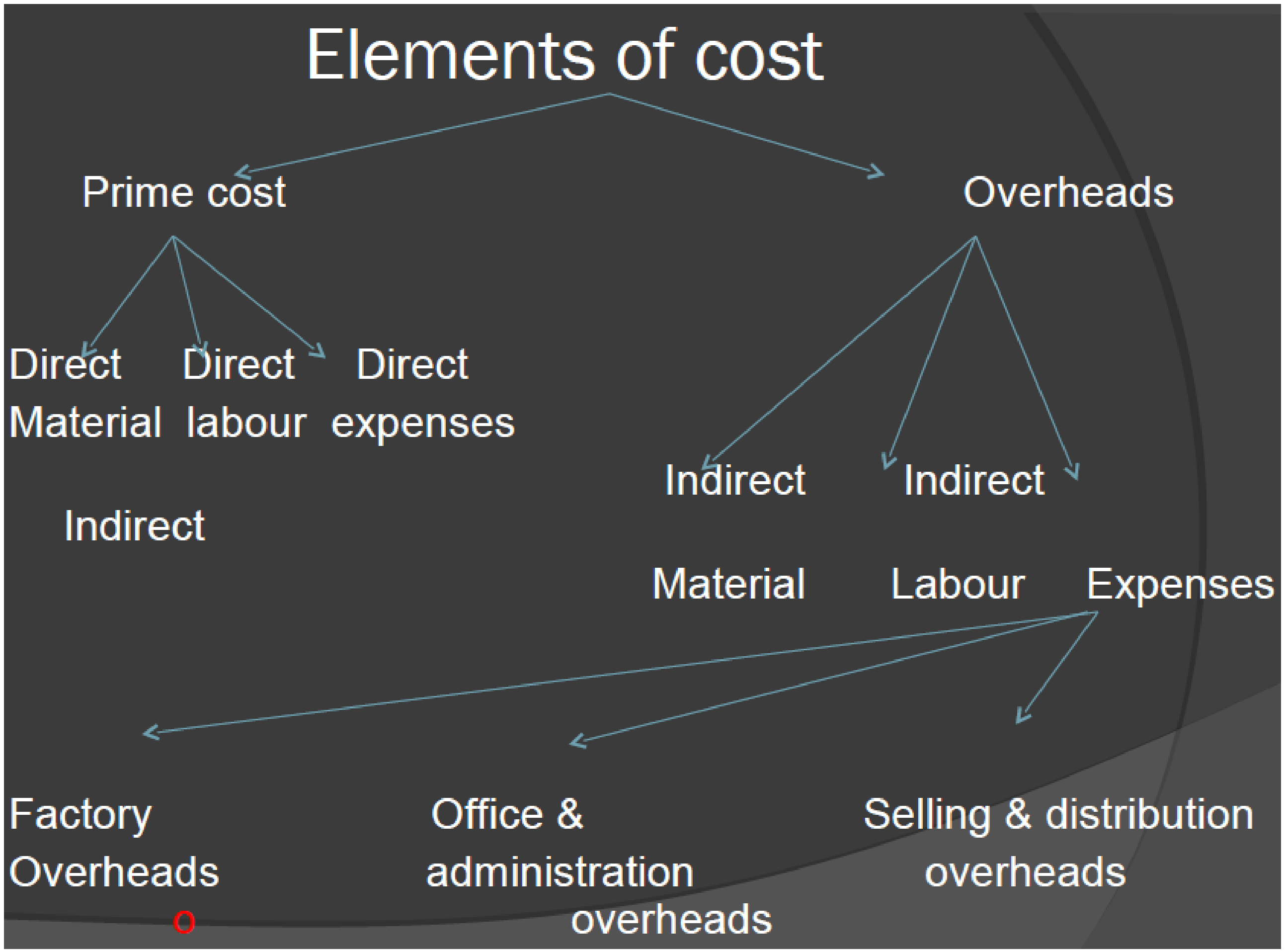
- As with every aspect of the product development process, the final activity is to ask:
- How well did we execute the DFE process?
- How can our DFE process be improved?
- What DFE improvements can be made on derivative and future products?

Product Costing/Cost of a Product

- **Product cost** refers to the costs incurred to create a **product**.
- Major components of Cost of product are
  - Material Cost
  - Labour Cost
  - Expense Cost
    - Factory Overhead cost
    - Administrative cost
    - Selling and Distribution Overhead

Elements of Cost




Elements of cost
Prime cost
Overheads
Direct Material
Direct labour
Direct expenses
Indirect
Indirect
Indirect
Material
Labour
Expenses
Factory Overheads
Office & administration overheads
Selling & distribution overheads

Material Cost

- Material indicates principal substances used in production. Examples are: cotton, jute, iron-ore, and silicon.
- The cost of material is further divided in to direct and indirect materials.
- Cost of commodities supplied
- It is of two types
  - Direct Material
  - Indirect material cost

Material Cost : Direct Material

- Direct materials refer to the cost of materials which become a major part of the finished product.
- Direct material is one which goes into a salable product or its use is directly essential for the completion of that product
- They are raw materials that become an integral part of the finished product and are conveniently and economically traceable to specific units of output.
- Some examples of direct materials are: raw cotton in textiles, crude oil to make diesel, steel to make automobile bodies.

Material Cost : Indirect Material

- These are materials which are used ancillary to manufacture and cannot be traced in to the finished product.
- Indirect material 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.
- Examples are glue, thread, nails, consumable stores, printing and stationary material

Labour cost

- Labor 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,commisions of the employees of an enterprise
- It is classified as
  – Direct Labour cost
  – Indirect Labour cost

Labour Cost :Direct Labour cost

- Direct labour is defined as the labour associated with workers who are engaged in the production process.
- It the labour costs for specific work performed on a product that is conveniently and economically traceable to end products.
- It is the cost of labour that can be identified directly with the manufacture of the product
- Direct labour is expended directly upon the materials comprising the finished product.
- Examples are the labour of machine operators and assemblers
- Eg: wages of a welder fabricating a structure form a part oif the total direct labour cost

Labour Cost :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.
- Like indirect materials, indirect labour forms part of the manufacturing overheads.
- Examples of indirect labor cost are wages paid to foremen, supervisors, storekeepers, time-keepers, salaries of office executives and the commission payable to sales representatives.

Expenses

- It is a collective title which refers to all charges other than those incurred as direct result of employing workers or obtaining material
- Two types
  - Direct Expense
  - Indirect Expenses

Expenses: Direct Expense Cost

- Direct expenses include any expenditure other than direct material and direct labor directly incurred on a specific cost unit (product or job).
- Such special necessary expenses can be identified with cost units and are charged directly to the product as part of the prime cost.
- Some examples of direct expenses are:

  (a) Cost of special layout, designing or drawings;

  (b) Hire of tools or equipment for a particular production or product;

  (c) Maintenance costs of such equipments.

Expenses: Indirect Expense Cost

- Indirect expenses are those incurred for the business as a whole rather than for a particular order, job or product.
- Examples of such expenses are rent, lighting, insurance charges.

Overheads

- Overheads may be defined as the aggregate of indirect material, indirect labor and indirect expenses.
- Thus, all indirect costs are overheads.
- These cannot be associated directly with specific products.
- Hence, the amount of overhead has to be allocated and apportioned to products and services on some reasonable basis.
- Overheads may be subdivided in to following groups:

a)Factory overheads.

b) Administrative overheads.

c) Selling and distribution overheads

Factory Overhead

- Overheads are all expenses other than direct expenses
- Factory overhead also called manufacturing expenses or factory burden may be defined as the cost of indirect materials, indirect labor and indirect expenses.
- Examples of such items are lubricants, cotton waste, hand tools, works stationery.
- Factory overhead includes
  - Building expenses
    - Rent
    - insurance
    - Repairs
    - Heating and Lighting
  - Indirect Labour
    - Supervisors and foreman
    - Shop clerk
    - Shop Inspectors

Administrative Overhead

- It consist of expenses incurred in the direction, control and administration of an enterprises
- Administrative overhead includes costs of planning and controlling the general policies and operations of business enterprises.
- Examples are
  - Office rent
  - Salaries and wages of clerks
  - Rates and taxes
  - Bank charges

Selling and distribution overhead

- Selling and distribution overhead is also known as marketing or selling overhead.
- Distribution expenses usually begin when the factory costs end.
- Such expenses are generally incurred when the product is in saleable condition.
- It covers the cost of making sales and delivering/dispatchin products.
- These costs include advertising, salesmen salaries and commissions, packing, storage, transportation, and sales administrative costs.

Price of a Product

- Prime cost=Direct material +Direct labour + Direct expenses
- Factory Cost =Prime Cost +Factory Overhead
- Cost of Production=Factory Cost +Administrative Over Head
- Cost of Sales=Cost of Production + Selling and Distribution Overhead
- Price=Cost of Sales+Profit

Design for Maintainability

- Maintainability is the degree to which the design can be maintained or repaired easily, economically and efficiently.
- Many durable or long life products need maintenance throughout their useful life.
- Consideration of a products maintenance features early in the design process can reduce maintenance costs, downtime and improve safety
- It is embodied in the design of the product.
- A lack of maintainability will be evident as high product maintenance costs, long out-of service times, and possible injuries to maintenance engineers.

Design for Maintainability

- One of the first things to consider is who will be undertaking the maintenance of the product?
- This is where anthropometric design comes in.
- A human factors engineer takes into consideration the critical dimensions such as vertical and horizontal reach, abdominal depth, shoulder breadth, standing eye height etc. of the target audience.
- The engineer, when applying the access dimension, should also consider the addition of Personal Protective Equipment (PPE), such as gloves, clothing thickness, kneeling pads and allowance for tools.

Types of Maintenance

- There are various forms of maintenance, mainly corrective maintenance (when something goes wrong), preventative maintenance (these are scheduled maintenance activities carried out to prevent a failure)
- 1. Preventative maintenance, for example replacing engine spark plugs every 30,000 km, or changing the oil filter.
  - Preventative maintenance requires the replacement of parts that are still working but are expected to fail soon.
  - For example an old oil filter may cause serious engine damage by starving bearings of oil, or allowing abrasive metal sludge into clean areas.
- 2. Remedial maintenance (repair or corrective maintenance), for example fitting a new vehicle starter motor where the existing motor has burned out. Remedial maintenance is performed after the product has failed

Factors to be considered for maintainability

- 1. Standardization
  - Select from the smallest set of parts with as much compatibility as possible.
  - Use standard parts in design
- 2. Modularization
  - Create a set of standard sizes, shapes, modular units.
  - If we expect to different models with different features, using a standard structure allows the interchange of compatible parts to alter functionally without changing the majority of the product.
  - example is light bulbs. You can select the functional bulbs (brightness, intensity, color, etc.) and they will fit in the same socket.

Factors to be considered for maintainability

- 3. Functional packaging
  - Gather all the required elements to complete a maintenance task in one kit.
- 4. Interchangeability
  - Single source, lack of compatibility with other similar functioning parts, another spare part in inventory, and limitations on future design changes if you want to stay in that custom form factor.
  - Select parts that are useful for a range of products or applications.

Factors to be considered for maintainability

- 5. Accessibility
  - If an item requires replacement or adjustment as part of the expected maintenance, then it should permit access.
  - Consider tools, lighting, environment, and experience of a maintenance crew.
  - Providing access panels is one factor, safety another.
- 6. Malfunction annunciation
  - A key step in performing maintenance is to know what caused the problem or which parts are damaged and require replacement.
    - Minimizing the need for inspection tools and diagnostic tasks minimizes the time/cost of the corrective maintenance tasks.
    - Let the system inform the technician what requires attention.

Factors to be considered for maintainability

- 7. Fault isolation
  - A failure in one part of a system can cause failure of other elements in the system.
  - If possible, try to avoid such a situation.
- 8. Identification
  - Name the parts with unique identifiers.
  - This streamlines documentation, procedures, and maintenance tasks.
  - Be consistent and provide meaningful or memorable naming conventions to avoid confusion.

Measures of Maintainability

- Mean Time Between Failure (MTBF) is a basic measure of reliability for repairable systems and it is the mean time that a machine operates between failures.
- Mean Time To Failure (MTTF) is a basic measure of reliability for non-repairable systems. It is the mean time expected until the first failure of a piece of equipment.
- Mean Time To Repair (MTTR) is the average time required to fix a failed component or device and return it to production status

Lines of Maintenance /Lines of Repair

- Geographical points (where the repair happens) of repair are often referred to as ‘lines of maintenance’ as follows:
- 1st line maintenance occurs at the point of use.
  - It could be at home, wherever a vehicle breaks down,.
  - It is appropriate to make the replacement of small modular items that require a minimum kit of tools and can be replaced within minutes.
- 2nd line maintenance occurs at a nearby maintenance depot.
  - This could be railway workshops, a car dealer,.
  - It is appropriate where an extended toolkit or special skills and processes are required, where adjustments must be made, where special handling is required, where the time to repair may be lengthy, where reassembly is complex, or where protection against the weather is important.
- 3rd line maintenance is undertaken by the manufacturer where the repair process requires skills and equipment beyond those available at the local service centre.

Ethics for Design

- *Ethics are the moral principles by which we judge right or wrong, good or bad.*
- They are the rules of conduct recognized by our society.
- "Ethics refers to well-founded standards of right and wrong that prescribe what humans ought to do, usually in terms of rights, obligations, benefits to society, fairness, or specific virtues."
- The term “ethics” is now widely used throughout the community including the government, business, education, legal, manufacturing and design sectors

Legal and Ethical Issues in Design

- Legal and ethical issues must be considered if a design is to be accepted by the market and/or the community.
- Assessing the impact of the design on the consumer:
  - The designer may consider safety, ease of use, built-in obsolescence and whether anyone will really benefit from the design.
- Protection of intellectual property:
  - The designer needs to be aware of patents which can be legally enforced, thus giving the patent holder exclusive rights to the invention.
- Privacy:
  - Certain inventions and uses of technology have the potential to invade privacy such as computer databases, security monitoring devices and sophisticated communication systems.
  - The *Privacy and Personal Information Protection Act* imposes obligation on agencies in their collection, storage, use and distribution of personal information.

Legal and Ethical Issues in Design

- Advertising of designs:
  - Some designs are forcefully advertised, especially to the young and impressionable.
  - Subliminal messages may also be considered unethical.

- The right to alter natural order:
  - Some people believe that designs should honour the concept of natural order.
  - Eg. Tomatoes are now genetically modified with flounder genes to improve their keeping qualities.
- Sustainable technology:
  - Designers may choose one design over another depending on whether the resources used in design and production are conserved while still meeting the production requirements.

Legal and Ethical Issues in Design

- Whether designs should be tested on animals and humans:
  - There has been a trend towards minimal testing on animals and many companies promote the fact their products are not tested on animals.
  - All animal (including human) testing is strictly controlled by government regulations.
- Environmental impact:
  - Designs have been modified and created because of concerns about the impact humans have on the environment through using both renewable and non-renewable resources.
- Minority groups:
  - Some groups in our society require special design attention such as the disabled, the elderly and isolated communities.
  - Often these designs are only required in small quantities and so it can be expensive or of low profitability.

Ethical Considerations

- As designers, it is important to be aware of the effect of our designs on other people and society in general
- Designers need to contemplate the morality of their research as well as the advances they are making.
- Design needs to be undertaken in a societal context
- Another ethical problem in the design industry is that of ownership of intellectual property and of inventions.
- Built in Obsolescence
  - **Planned obsolescence**, or **built-in obsolescence**, in industrial design is a policy of planning or designing a product with an artificially limited useful life, so it will become obsolete (that is, unfashionable or no longer functional) after a certain period of time.
  - The rationale behind the strategy is to generate long-term sales volume by reducing the time between repeat purchases (referred to as "shortening the replacement cycle")

Ethical Considerations

- Avoiding processes and technologies that affect the safety of the employees and public,
- Producing product safe for customers,
- Waste product utilization and recycling,
- Profiting from products bad for health (drugs, cigarettes, alcohol) and people (gambling)

Examples

- Car
  - Crash Test
  - Emission Level
  - Standards
- Mobile Phones
  - Pre-certification testing
  - Conformance testing (e.g. according to 3GPP standards)
  - Regulatory testing (RED, FCC, ISED Canada etc.)
  - Interoperability testing
  - Antenna testing (OTA) – recognized by Vodafone, T-Mobile, AT&T etc.
  - Battery life testing
  - Safety, SAR, health testing
  - Application testing