

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - 5 SEMESTER – MID TERM – W26 – ANSWER BANK

Subject Name & Code:

PRODUCT DESIGN AND VALUE ENGINEERING - BE05000581

Chapter - 1: Voice of Customer (CO1)

3 Marks Questions

1) What is voice of customer in product design?

Voice of Customer (VoC) is a systematic process of capturing customers' requirements, expectations, preferences, and feedback about a product.

- **Purpose:** To understand what customers truly need/want
 - **Methods:** Surveys, interviews, focus groups, observations
 - **Output:** Translated into product specifications and design requirements
 - **Goal:** Develop products that satisfy customer expectations
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2) Explain how voice of customer useful in Product design and development.

VoC is essential for successful product development:

- **Identifies real needs:** Uncovers actual customer problems and requirements
 - **Reduces failure risk:** Minimizes product rejection in market
 - **Guides design decisions:** Provides clear direction for design specifications
 - **Enhances satisfaction:** Ensures final product meets customer expectations
 - **Competitive advantage:** Creates products customers actually want
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4 Marks Questions

1) Write note: Customers needs in product design.

Customer needs represent the requirements and expectations customers have from a product.

Key Aspects:

- **Functional needs:** Basic performance requirements (what product must do)
- **Emotional needs:** Aesthetics, brand perception, user experience
- **Social needs:** Status, recognition, belongingness associated with product
- **Economic needs:** Value for money, affordability, cost-benefit ratio

Characteristics:

- **Dynamic:** Change over time and with market trends
 - **Hierarchical:** Basic needs to advanced/premium requirements
 - **Context dependent:** Vary across demographics and usage scenarios
 - Must be translated into measurable design specifications
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2) Explain the following with reference to identifying customers' needs: - Gathering raw data from customers.

Gathering Raw Data: Process of collecting unfiltered customer information through direct interaction.

Methods:

- **Interviews:** One-on-one conversations (structured/unstructured)

- **Focus groups:** Group discussions facilitated by moderator
- **Surveys:** Questionnaires for large sample sizes
- **Observations:** Watching customers use existing products
- **Ethnographic studies:** Studying customers in their natural environment

Key Consideration: Record data exactly as expressed (verbatim) - no interpretation during collection

3) What are the different methods for collecting customer needs? Explain in brief.

Primary Methods:

- **Surveys/Questionnaires:** Large samples, quantitative data, cost-effective
- **Interviews:** In-depth understanding, qualitative insights, flexible
- **Focus Groups:** Group dynamics, brainstorming, interactive feedback
- **Customer Observation:** Real usage patterns, unbiased behavior data
- **Ethnographic Research:** Deep cultural/contextual understanding

Secondary Methods:

- Customer complaints database analysis
 - Social media monitoring
 - Competitive product reviews
 - Warranty claims analysis
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7 Marks Questions

1) Explain the following with reference to identifying customers' needs: (1) Gathering raw data from customers (2) Interpreting raw data in terms of customers' needs

(1) Gathering Raw Data from Customers:

- **Definition:** Direct collection of unfiltered customer statements and observations
- **Techniques:**
 - Individual interviews (structured/semi-structured)
 - Focus groups with 6-10 participants
 - Observational studies in natural settings
 - Online surveys and feedback forms
 - Social media sentiment analysis
- **Best Practices:**
 - Ask open-ended questions
 - Avoid leading questions
 - Record verbatim responses
 - Capture both stated and unstated needs

(2) Interpreting Raw Data in Terms of Customers' Needs:

- **Definition:** Translating raw customer statements into actionable design requirements
 - **Process:**
 - **Categorization:** Group similar needs together
 - **Prioritization:** Rank needs by importance and urgency
 - **Translation:** Convert vague statements into specific metrics
 - **Validation:** Verify interpretations with customers
 - **Example:** "My phone battery dies too quickly" → "Battery life $\geq$ 12 hours under standard usage"
 - **Tools:** Affinity diagrams, Kano model, Quality Function Deployment (QFD)
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2) Discuss: Relative Importance of customer need.

Definition: Assigning priority weights to different customer needs based on their

significance.

Factors Determining Relative Importance:

- **Criticality to product function:** Must-have vs. nice-to-have features
- **Frequency of use:** How often the feature is utilized
- **Customer satisfaction impact:** Effect on overall satisfaction
- **Competitive positioning:** Differentiation advantage
- **Cost implications:** Development and manufacturing costs
- **Technical feasibility:** Ease of implementation

Methods for Assessment:

- **Pairwise comparison:** Comparing needs in pairs
- **Rating scales:** 1-10 importance ranking
- **Analytic Hierarchy Process (AHP):** Structured mathematical approach
- **Kano Model:** Classifies needs as basic, performance, or excitement

Importance in Design:

- Guides resource allocation
 - Focuses engineering efforts
 - Helps make trade-off decisions
 - Ensures critical needs are addressed first
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Chapter - 2: Product Design (CO2)

3 Marks Questions

1) What is product life cycle?

Product Life Cycle (PLC) is the sequence of stages a product goes through from introduction to market withdrawal.

Stages:

- **Introduction:** New product launch, low sales, high costs
- **Growth:** Sales increase, profits rise, competition emerges
- **Maturity:** Sales peak, stable market, intense competition
- **Decline:** Sales decrease, market saturation, phase-out

2) What are the sources of ideas for developing a new product?

Internal Sources:

- R&D department research
- Employee suggestions
- Sales force feedback
- Manufacturing/engineering improvements

External Sources:

- Customer feedback/complaints
- Competitor product analysis
- Market research studies
- Suppliers and vendors
- Trade shows/exhibitions
- Academic research
- Government publications

3) Discuss steps involved in product planning process.

Steps:

- **Idea Generation:** Collecting potential product concepts
- **Idea Screening:** Filtering viable vs. non-viable ideas
- **Concept Development:** Detailed product concept creation
- **Business Analysis:** Market potential, cost, profitability assessment
- **Product Development:** Prototype building and testing
- **Test Marketing:** Limited market launch
- **Commercialization:** Full-scale production and market launch

4) Distinguish between Engineering design and Industrial Design.

Engineering Design	Industrial Design
Focuses on Functionality	Focuses on Aesthetics
Structural integrity, durability	Appearance, ergonomics
Engineering principles	Art, human factors
Performance optimization	User experience

Engineering Design	Industrial Design
Technical feasibility	Visual appeal
Example: Circuit design	Example: Product shape

5) What are various types of product.

Classification Based on:

- **By Tangibility:** Tangible goods, intangible services
- **By Usage:** Consumer products, industrial products
- **By Durability:** Durable goods, non-durable goods
- **By Differentiation:** Standardized products, customized products
- **By Function:** Core product, enhanced product, extended product

4 Marks Questions

1) Give product classification with example.

1. Consumer Products: For personal use

- Convenience goods (FMCG) → Example: Toothpaste
- Shopping goods → Example: Furniture
- Specialty goods → Example: Luxury watch
- Unsought goods → Example: Insurance

2. Industrial Products: For business use

- Raw materials → Example: Steel
- Capital goods → Example: Machinery
- Operating supplies → Example: Lubricants
- Component parts → Example: Electronic chips

3. By Durability:

- Durable goods (3+ years) → Example: Refrigerator
- Non-durable goods (<3 years) → Example: Food items

2) Explain the procedure for Calculating the Life Cycle Cost.

Life Cycle Cost (LCC) = Total cost of owning and operating product over its entire life.

Procedure:

- **Identify cost categories:**
 - Research & Development cost
 - Production/Manufacturing cost
 - Distribution/Marketing cost
 - Operating/Maintenance cost
 - Disposal/Retirement cost

Calculate using formula:

$$\text{LCC} = \text{IC} + \text{AC} + \text{MC} + \text{DC}$$

Where:

- **IC** = Initial Cost (Design + Production + Installation)
- **AC** = Annual Operating Cost × Product Life
- **MC** = Maintenance & Repair Cost
- **DC** = Disposal & Decommissioning Cost

Tools: Net Present Value (NPV), Equivalent Annual Cost (EAC) for comparison

3) Discuss Factors affecting Product design and development.

Internal Factors:

- **Company resources:** Financial, technical, human resources
- **R&D capability:** Innovation capacity and expertise
- **Manufacturing competence:** Production facilities and skills
- **Organizational culture:** Risk-taking and creativity

External Factors:

- **Customer needs:** Market demands and preferences
- **Competition:** Competitive pressure and benchmarking
- **Technology:** Latest technological developments
- **Regulatory requirements:** Safety, standards, compliance
- **Supplier capabilities:** Component availability and quality
- **Economic factors:** Market trends and purchasing power
- **Environmental concerns:** Sustainability, eco-design

4) Discuss steps involved in product planning process.

(Same as 3 Marks Q3 - Expanded)

Step 1 - Idea Generation:

- Sources: Internal (R&D, employees) and External (customers, competitors)
- Techniques: Brainstorming, TRIZ, customer surveys

Step 2 - Idea Screening:

- Evaluate ideas against company capabilities and objectives
- Use scoring models, checklists for feasibility assessment

Step 3 - Concept Development:

- Detailed description of product idea
- Define features, benefits, target market

Step 4 - Business Analysis:

- Market potential forecasting
- Cost projections and profitability analysis
- Break-even analysis

Step 5 - Product Development:

- Prototype creation
- Engineering design and testing

Step 6 - Test Marketing:

- Limited market launch
- Gather feedback and make modifications

Step 7 - Commercialization:

- Full production and launch
- Market entry strategy implementation

5) What are the challenges for Product Design and Development?

Key Challenges:

- **Rapid technological changes:** Keeping pace with evolving technologies
- **Short product life cycles:** Faster innovation requirements
- **Global competition:** International market pressures
- **Cost constraints:** Meeting performance within budget
- **Quality demands:** Increasing customer expectations
- **Time-to-market pressure:** Faster development cycles
- **Regulatory compliance:** Meeting standards and certifications
- **Sustainability requirements:** Environmental considerations

- **Resource limitations:** Financial and talent constraints
 - **Risk management:** Innovation uncertainty
-

7 Marks Questions

1) Explain characteristics successful product design.

Characteristics:

- **Customer-Centric:** Addresses real customer needs and provides value
 - **Functional Excellence:** Performs intended tasks reliably and efficiently
 - **Aesthetic Appeal:** Visually pleasing with good ergonomics
 - **Quality Oriented:** Durable, reliable, consistent performance
 - **Cost-Effective:** Optimal manufacturing and life cycle cost
 - **Innovative:** Unique features or solutions, distinct from competitors
 - **Sustainable:** Environmentally friendly and socially responsible
 - **User-Friendly:** Easy to use, maintain, and operate
 - **Scalable:** Capable of mass production and modifications
 - **Regulatory Compliant:** Meets all safety and industry standards
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2) What is Ergonomics? State its application in product design process.

Ergonomics: Scientific study of the interaction between humans and products/systems to optimize human well-being and overall system performance.

Applications in Product Design:

- **User Interface Design:** Layout, controls, displays
- **Physical Comfort:** Handles, seating, dimensions
- **Anthropometry:** Product dimensions matching human body
- **Safety Design:** Prevent user injuries and fatigue
- **Cognitive Ergonomics:** Information processing and mental workload
- **Accessibility:** Products usable by elderly and differently-abled
- **User Experience (UX):** Overall interaction satisfaction

Implementation Stages:

- Analyze user characteristics (size, strength, reach)
 - Apply anthropometric data to design
 - Test prototypes with users
 - Refine based on feedback
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3) Explain material selection process in product design.

Process:

- **Define Design Requirements:** Performance, function, environmental conditions
- **Identify Candidate Materials:** Based on properties and availability
- **Evaluate Material Properties:**
 - Mechanical: Strength, hardness, fatigue, creep
 - Physical: Density, thermal, electrical, magnetic
 - Chemical: Corrosion resistance, reactivity
- **Assess Manufacturing Suitability:** Forming, machining, joining

Selection Criteria:

- Technical: Properties and performance
- Economic: Cost and availability
- Environmental: Sustainability and recyclability
- Functional: Weight, durability, aesthetics

Tools:

- Ashby material selection charts
- Performance indices (Strength/Weight, Stiffness/Cost)
- Cost-benefit analysis

4) What are the challenges faced by the design engineer in current market scenario?

Challenges:

- **Technology disruption:** AI, IoT, 3D printing changing design approaches
- **Shorter development cycles:** Faster time-to-market requirements
- **Cost minimization:** Balancing quality with cost constraints
- **Globalized markets:** Designing for diverse international standards
- **Sustainability pressure:** Eco-friendly designs and circular economy
- **Customization demand:** Mass customization vs. standardization
- **Interdisciplinary complexity:** Integration of multiple technologies
- **Skills gap:** Keeping updated with latest tools and methods
- **Supply chain issues:** Sourcing and logistics disruptions
- **IP protection:** Patenting and copycat competition
- **Ethical considerations:** Safety, privacy, social impact
- **Remote collaboration:** Managing distributed teams

5) Explain the process of Brain storming and Idea gaming with example.

Brainstorming:

Group creativity technique to generate many ideas through open discussion.

Process:

- **Define problem:** Clearly state what needs to be solved
- **Form team:** 6-10 diverse participants
- **Set rules:** No criticism, encourage wild ideas, build on others
- **Generate ideas:** Open, rapid fire idea generation
- **Record ideas:** Write/draw all ideas on board
- **Evaluate:** After session, analyze and shortlist feasible ideas

Example: Developing a new water bottle → Ideas: Self-cooling, UV purification, collapsible, Bluetooth tracking, plant-based bottle

Idea Gaming (Gamestorming):

Creative thinking method using game mechanics to generate and refine ideas.

Techniques:

- **Analogy games:** Compare product to something else
- **Role-playing:** Think from perspective of user or competitor
- **What if? games:** Challenge assumptions
- **Mind mapping:** Visual idea organization

Example: "What if our coffee maker could talk?" → Voice-activated brewing, maintenance reminders, personalized recommendations

6) What is Product life cycle? Explain each stages with example.

Definition: PLC describes sales and profit evolution of a product from introduction to removal.

Stages:

1. Introduction Stage:

- Low sales, negative profits (high R&D/marketing costs)
- Limited competitors, early adopters only
- High promotion and distribution costs
- **Example:** First electric vehicles (Tesla Roadster)

2. Growth Stage:

- Rapid sales increase, profits improve
- More competitors enter market
- Prices reduce due to economies of scale
- **Example:** Smartphones after iPhone launch

3. Maturity Stage:

- Sales peak, stable market share
- Intense competition, price wars
- Profits decline, market saturation
- Differentiation strategy important
- **Example:** Standard laptops, refrigerators

4. Decline Stage:

- Sales decrease, profits decline
- New technology replaces old
- Product phase-out or niche market
- **Example:** Traditional landline phones, CDs

7) What is generic development process?

Definition: A structured framework used by organizations to develop new products, adaptable across industries.

Stages:**Phase 0 - Planning:**

- Feasibility assessment, strategy definition

Phase 1 - Concept Development:

- Needs identification, concept generation and selection

Phase 2 - System-Level Design:

- Architecture definition, subsystem design, component decomposition

Phase 3 - Detail Design:

- Complete engineering specifications, 3D modeling, final drawings

Phase 4 - Testing and Refinement:

- Prototype testing, performance validation, modifications

Phase 5 - Production Ramp-Up:

- Process development, tooling, volume production start

Key Characteristics:

- **Iterative:** May cycle back to earlier phases
- **Cross-functional:** Engineering, marketing, manufacturing collaborate
- **Customer-focused:** Stages include customer input
- **Gate-based:** Reviews at each phase for go/no-go decisions

Variations:

- Agile (for software)
 - Stage-Gate (hardware)
 - Waterfall (sequential)
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Chapter - 3: Product Configuration and Design for Function (CO2)

3 Marks Questions

1) What is Product Function? How function analysis is carried out.

Product Function: The intended purpose or action a product performs for its user.

Function Analysis Process:

- **Define primary function:** Main purpose (what the product does)
- **Identify secondary functions:** Supporting functions
- **Break down into sub-functions:** Decompose complex functions
- **Analyze relationships:** How functions interact
- **Define function structure:** Sequence of operations

Tools: Function tree, function matrix, FAST diagram

2) What is concept development?

Concept Development: Phase where product ideas are transformed into detailed concepts with descriptions, features, and specifications.

Activities:

- Clarify customer needs
- Generate product concepts
- Evaluate and select best concepts
- Test concepts with customers
- Define final concept with specifications

4 Marks Questions

1) Differentiate target specification and final specification of product.

Target Specification	Final Specification
Initial draft/rough set of metrics	Complete and approved documentation
Based on preliminary customer needs	Refined after concept selection
May change during development	Frozen and fixed for production
Broad ranges (e.g., weight 5-7 kg)	Precise values (e.g., weight 6.2 kg)
No testing validation	Validated with prototypes
Used for concept evaluation	Used for design and manufacturing

2) Discuss in brief Concept Development Techniques. (Front End Process)

Techniques:

- **External Search:** Customer research, benchmarking, patents review
- **Creative Methods:** Brainstorming, TRIZ, morphological analysis
- **Internal Search:** Individual thinking, team brainstorming
- **Concept Screening:** Decision matrices, Pugh selection method
- **Concept Testing:** Customer feedback, prototype testing
- **System Design:** Functional decomposition, architecture definition

- **Prototyping:** Rapid prototyping, CAD modeling

Front End Process Steps:

- **Opportunity Identification**
- **Concept Generation**
- **Concept Evaluation**
- **Concept Selection**

3) Discuss concept deferment in product design.

Concept Deferment: Strategy of delaying specific design decisions to maintain flexibility and accommodate changes.

Benefits:

- **Accommodates change:** Adapts to new requirements
- **Reduces risk:** Avoids wrong commitments
- **Facilitates customization:** Easier to modify for different markets
- **Handles uncertainty:** Allows optimization with better data

Examples:

- Platform design (common base, different tops)
- Modular architecture (interchangeable components)
- Postponement (manufacturing after receiving orders)

Drawbacks:

- Increased complexity
- Potential delay in time-to-market
- Higher costs in some cases

7 Marks Questions

1) Explain the activities carried out during concept development phase with example.

Activities:

1. Identify Customer Needs:

- Gather raw data from customers
- Interpret into product specifications
- **Example:** For a laptop, customer says "lightweight" → weight target < 1.5 kg

2. Establish Target Specifications:

- Define performance metrics
- Set quantitative targets
- **Example:** Battery life = 10 hours, weight = 1.4 kg

3. Generate Product Concepts:

- Brainstorm multiple solutions
- Use creative techniques
- **Example:** Concepts for laptop cooling: fans, heat pipes, liquid cooling, passive cooling

4. Select Product Concept:

- Evaluate concepts against criteria
- Use decision matrices
- **Example:** Choose heat pipe + fan combination

5. Test Product Concept:

- Get customer feedback on concepts
- Build proof-of-concept prototypes
- **Example:** Show mockups to users for feedback

6. Set Final Specifications:

- Freeze specifications
- Prepare for detailed design
- **Example:** Final laptop specs: weight 1.45 kg, 12mm thickness

Example - Smartphone Development:

- Need: Good camera → 12 MP, 3x zoom
- Concept: Single lens, dual lens, triple lens
- Test: User preference for photo quality
- Select: Triple lens concept
- Final specs: 12MP main, 8MP telephoto, 5MP ultrawide

2) Discuss function evaluation techniques.

Function Evaluation: Systematic assessment of product functions to optimize design.

Techniques:

1. Functional Analysis System Technique (FAST):

- Creates logic diagram showing functional relationships
- Answers "How" and "Why" questions
- Identifies critical and redundant functions

2. Value Analysis/Value Engineering (VA/VE):

- Evaluates function-cost relationship
- Maximizes value = Function / Cost
- Seeks alternative ways to achieve function

3. Function Cost Analysis:

- Assigns costs to each function
- Identifies high-cost, low-value functions
- Targets cost reduction opportunities

4. Kano Model:

- Classifies functions by user satisfaction impact
- Basic, Performance, Excitement categories
- Guides feature prioritization

5. Quality Function Deployment (QFD):

- Matches functions to customer requirements
- House of Quality matrix

6. Pareto Analysis:

- Identifies vital few functions with most impact

7. Sensitivity Analysis:

- Determines how function variation affects performance

3) What are the Important factors to be consider while writing product specification.

Factors:

- **Product Function:** Primary purpose and intended use
- **Performance Metrics:** Measurable technical parameters
- **Quality Standards:** Reliability, durability, safety
- **Dimensions and Weight:** Physical size requirements
- **Materials Specification:** Required properties and composition
- **Manufacturing Tolerances:** Acceptable variations
- **Regulatory Compliance:** Safety, environmental, industry standards
- **Cost Targets:** Manufacturing and life cycle costs
- **User Interface/Ergonomics:** Ease of use and comfort
- **Environmental Conditions:** Operating temperature, humidity, etc.
- **Service Life:** Expected product lifetime

- **Packaging and Shipping:** Protection and transportation
- **Maintenance Requirements:** Servicing ease and intervals
- **Aesthetic Requirements:** Color, finish, appearance

4) Explain with suitable example: Concept development process.

Process:

Step 1: Clarify Problem

- Understand customer needs and product opportunity
- **Example:** Need a portable coffee maker for travelers

Step 2: Search Externally

- Research existing products, patents, and technologies
- **Example:** Study portable coffee presses, capsule systems

Step 3: Search Internally

- Generate ideas using creative techniques
- **Example:** Brainstorming → Aeropress, espresso, french press

Step 4: Explore Systematically

- Use structured methods like morphological chart
- **Example:** Options combinations

Component	Option A	Option B	Option C
Power	Manual	Battery	External
Type	Press	Filter	Pump
Size	Small	Medium	Large

Step 5: Reflect on Solutions

- Evaluate and refine concepts
- **Example:** Combine "Manual Press + Small" for minimalism

Step 6: Select Final Concept

- Use scoring matrix
- **Example:** Chosen concept - Manual hand-press coffee maker

Step 7: Test Concept

- Build prototype, test with customers
- **Example:** Users test portability and coffee quality

Step 8: Set Specifications

- Finalize technical requirements
- **Example:** Weight < 500g, makes 2 cups, easy to clean

5) Write note: Design for function techniques.

Definition: Systematic methods to ensure product functions efficiently and effectively.

Techniques:

1. Functional Decomposition:

- Break product into sub-functions
- Identify relationships between functions
- Organize into function tree

2. Morphological Chart:

- Matrix combining sub-function solutions
- Generates multiple design alternatives
- Enables systematic concept generation

3. FMEA (Failure Mode Effects Analysis):

- Identifies potential failure modes
- Assesses risk priority
- Prevents functional failures

4. Design of Experiments (DOE):

- Optimizes functional parameters
- Tests multiple variables systematically
- Improves performance consistency

5. Taguchi Method:

- Robust design for function stability
- Reduces performance variation
- Focuses on signal-to-noise ratio

6. Modular Design:

- Groups functions into modules
- Enables independent improvement
- Facilitates customization

7. Robust Design:

- Function unaffected by variations
- Considers environmental factors
- Ensures consistent performance

8. Concurrent Engineering:

- Parallel development of functions
 - Cross-functional collaboration
 - Faster development cycle
-

Chapter - 7: Value Engineering (CO5)

3 Marks Questions

1) Why value engineering is very important in product design?

Importance:

- **Cost reduction:** Eliminates unnecessary costs while maintaining quality
- **Improves value:** Maximizes function/cost ratio
- **Enhances competitiveness:** Offers better products at lower prices
- **Resource optimization:** Best use of available resources
- **Innovation driver:** Encourages creative alternatives
- **Customer satisfaction:** Better products at affordable prices
- **Sustainability:** Reduces waste and resource consumption

2) Define Value, Value Analysis and Value engineering.

Value: The ratio of Function (Performance/Utility) to Cost.

Value = Function ÷ Cost

Value Analysis (VA): Systematic method to improve value by evaluating existing products to reduce costs without compromising function.

Value Engineering (VE): Systematic method applied during new product development to optimize value by improving function-to-cost ratio.

Key Difference:

- VA = Applied to existing products
- VE = Applied during design/development stage

3) What is Fast diagram?

FAST (Function Analysis System Technique) Diagram: Visual tool that maps functions of a product in a logical sequence.

Purpose:

- Shows "How" a function is accomplished
- Shows "Why" a function is required
- Identifies critical and redundant functions

Structure:

text

Why? ← Function → How?

- Read left-to-right: "How to achieve function"
- Read right-to-left: "Why this function is needed"

Example - Pencil:

- Make marks → Transfer graphite → Contain graphite → Hold graphite

4) Discuss considerations of Human Aspects in Value Engineering?

Human Considerations:

- **User acceptance:** Ensure alternative solutions satisfy users
 - **Ergonomics:** Maintain comfort and ease of use
 - **Safety:** Eliminate risks to users and operators
 - **Aesthetics:** Preserve visual appeal and branding
 - **Ease of operation:** Simpler processes reduce errors
 - **Training requirements:** Solutions should not increase training burden
 - **Social impact:** Consider user community and societal effects
 - **Psychological factors:** User confidence, trust, satisfaction
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5) What is worth? How it is evaluated?

Worth: The minimum cost required to provide a specific function, representing the ideal/lowest possible cost.

Evaluation Methods:

- **Comparison:** Compare with similar products performing same function
- **Estimation:** Expert judgment of minimal cost
- **Functional cost analysis:** Break down to sub-functions and estimate costs
- **Market benchmarking:** Industry standards and competitor pricing
- **Team consensus:** Multi-disciplinary team discussion

Formula:

- $\text{Value} = \text{Worth} / \text{Cost}$ (often used in VE)

Example: If flashlight worth = ₹50, but cost = ₹100, value = 0.5 (improvement needed)

4 Marks Questions

1) Explain Reduction of cost of components.

Approaches:

- **Material substitution:** Cheaper material with adequate properties
- **Manufacturing process change:** More efficient production methods
- **Standardization:** Use common, off-the-shelf components
- **Design simplification:** Reduce number of parts
- **Tolerance relaxation:** Accept wider tolerances where possible
- **Supplier negotiation:** Better pricing or sourcing alternatives
- **Component integration:** Combine multiple parts into one
- **Value analysis:** Eliminate unnecessary features/overdesign
- **Alternate manufacturing:** In-house vs. outsourced comparison

Checklist:

- Is every part necessary?
 - Can costs be transferred to supplier?
 - Can design be modified for lower-cost materials?
 - Can production methods be improved?
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2) Discuss: (i) Political Value and Social Value (ii) Plan value and Time value.

(i) Political Value:

- Value related to political acceptability and government compliance
- Includes regulatory adherence, tax implications
- **Example:** Products aligned with government policies (e.g., "Make in India")

Social Value:

- Contribution to societal well-being
- Includes employment, safety, environmental responsibility
- **Example:** Solar panels providing clean energy

(ii) Plan Value:

- Value when product meets planned/designed specifications
- Function as intended by design
- **Example:** Car achieving designed fuel efficiency

Time Value:

- Value changes with time
- Cost of delay in product launch
- Market timing importance
- **Example:** Early launch captures more market share

3) What are various types of values in VE?

Types of Value:

- **Use Value:** Performance of intended function (What it does)
- **Esteem Value:** Aesthetic appeal, brand perception (Desire to possess)
- **Exchange Value:** Property/market value (What it can be traded for)
- **Cost Value:** Total cost incurred (What was spent)
- **Time Value:** Value over time (When product is delivered)
- **Place Value:** Value at different locations (Where it's available)
- **Form Value:** Value due to physical attributes (Shape, size, weight)

Relationship:

- **Value = Function ÷ Cost**
- **Total Value = Use Value + Esteem Value** (from customer perspective)

4) WRITE NOTE: Value engineering tools and techniques.

Tools and Techniques:

- **FAST Diagram:** Functional logic mapping
- **Brainstorming:** Creative idea generation
- **Pareto Analysis:** Focus on high-cost areas
- **Decision Matrix:** Compare alternatives systematically
- **Function Cost Matrix:** Cost assignment to functions
- **Cause-Effect Analysis:** Identify cost drivers
- **ABC Analysis:** Prioritize components by cost/volume
- **Benchmarking:** Compare with industry best practices
- **Value Analysis Value Engineering (VA/VE) Workshop:** Cross-functional team sessions
- **Life Cycle Costing:** Evaluate total ownership cost
- **Sunk Cost Analysis:** Future cost considerations only
- **TRIZ:** Structured innovation methodology

Creative Techniques:

- Checklist method (Osborn's checklist)
- Morphological analysis
- Attribute listing
- Forced relationship

5) Discuss importance of value engineering for cost reduction of any product.

Importance:

- **Systematic approach:** Structured method, not random cuts
- **Function focused:** Reduce costs without sacrificing performance
- **Cross-functional collaboration:** Team approach brings diverse perspectives
- **Early application:** Most effective during development phase
- **Continuous improvement:** Ongoing process throughout product life
- **Competitive advantage:** Lower costs = better market position
- **Waste elimination:** Identifies unnecessary operations and materials
- **Quality maintenance:** Cost reduction without compromising quality
- **Resource optimization:** Better utilization of available resources
- **Sustainability:** Less material usage, reduced environmental impact

Example: Industrial pump - VE identified expensive casting method could be replaced with fabrication, saving 20% cost while maintaining performance.

7 Marks Questions

1) Explain various phases of VE.

VE follows a Job Plan with phases:

Phase 1 - Information Phase:

- Collect all relevant data about product, costs, and functions
- Understand existing design and customer requirements
- Identify high-cost areas and critical components
- Develop function matrix and FAST diagram

Phase 2 - Creative Phase:

- Generate alternative solutions without evaluation
- Use brainstorming and creative techniques
- Challenge all assumptions
- No criticism of ideas at this stage

Phase 3 - Evaluation Phase:

- Evaluate and screen alternative ideas
- Assess feasibility, cost, performance, and value
- Shortlist best alternatives for further analysis
- Use decision matrices and scoring methods

Phase 4 - Development Phase:

- Develop detailed proposals for selected alternatives
- Conduct technical analysis and cost estimates
- Test and validate performance
- Prepare implementation plan

Phase 5 - Presentation Phase:

- Present recommendations to management
- Justify changes with data and analysis
- Prepare implementation roadmap
- Address concerns and refine

Phase 6 - Implementation Phase:

- Execute approved changes
- Monitor progress and outcomes
- Document results and lessons learned
- Verify cost savings achieved

2) What are the steps involved in Initiating Value Engineering Programme?

Steps:

- **Step 1: Management Commitment:**
 - Secure top management support and resources
 - Define program objectives and scope
- **Step 2: Select Product/Project:**
 - Identify products with high cost or potential for improvement
 - Consider strategic importance and market impact
- **Step 3: Form Value Team:**
 - Assemble cross-functional team (design, manufacturing, purchasing, marketing)
 - Appoint experienced leader/facilitator
- **Step 4: Define Function:**
 - List product functions
 - Classify as basic vs. secondary functions

- **Step 5: Data Collection:**
 - Gather cost, performance, and technical data
 - Collect market and competitor information
- **Step 6: Function Analysis:**
 - Apply FAST diagram
 - Conduct function cost analysis
- **Step 7: Generate Alternatives:**
 - Conduct creative sessions
 - Use various ideation techniques
- **Step 8: Evaluate and Develop:**
 - Screen and evaluate ideas
 - Develop detailed proposals
- **Step 9: Present Recommendations:**
 - Prepare report/presentation
 - Get approval from management
- **Step 10: Implement:**
 - Execute approved changes
 - Track and monitor results

3) Explain how to determine and evaluate value with suitable example.

Determination:

$$\text{Value} = \text{Function} \div \text{Cost}$$

Step 1 - Determine Function:

- Identify what the product does (primary and secondary functions)
- **Example:** Bicycle's function = "Transport person"

Step 2 - Determine Cost:

- Calculate total product cost (materials, labor, overhead)
- **Example:** Bicycle cost = ₹3,000

Step 3 - Determine Worth:

- Estimate minimum cost to achieve function
- **Example:** Worth of transport function $\approx$ ₹1,800 (based on alternative)

Step 4 - Calculate Value:

- $\text{Value} = \text{Worth} / \text{Actual Cost}$
- **Example:** $\text{Value} = 1,800 / 3,000 = 0.6$

Evaluation:

If Value < 1: Improvement needed

Approaches to Improve Value:

- Increase function with same cost
- Decrease cost with same function
- Increase function, increase cost proportionally
- Reduce cost, reduce function (if acceptable)
- Significantly improve function, slightly increase cost

Example - Bicycle:

- Function = Transport person (1 function)
- Cost = ₹3,000
- Worth = ₹1,800 (as assessed via alternative solutions)
- Value = 0.6
- Need to reduce cost to ₹1,800 or add functions worth ₹1,200

4) Value Engineering is tool for productivity. Justify.

Justification:

Value Engineering directly improves productivity by:

- **Maximizing output per input:** More function value per unit cost
- **Resource optimization:** Better utilization of materials, labor, and energy
- **Waste reduction:** Eliminates unnecessary operations and features
- **Process improvement:** Identifies and removes inefficiencies
- **Quality enhancement:** Better quality at same or lower cost
- **Innovation:** New solutions with better cost-performance ratio
- **Time savings:** Faster, more efficient processes
- **Cycle time reduction:** Streamlined manufacturing and assembly
- **Reusability:** Modular designs allowing component reuse
- **Standardization:** Fewer parts, reduced inventory, lower training needs

Productivity Formula:

Productivity = Output ÷ Input

VE Impact:

- Increase output (function/quality)
- Decrease input (cost/resources)
- Net result = Higher productivity

Example: VE improved a manufacturing process, reducing assembly time by 30% while maintaining quality. Productivity increased by 43%.

5) Discuss steps of writing functions in value engineering with suitable example.

Steps:

Step 1: Identify All Functions:

- List everything the product does
- Use two-word (verb + noun) format
- **Example - Bicycle:**
 - Transport person
 - Steer direction
 - Support rider
 - Stop motion
 - Provide comfort
 - Show speed

Step 2: Classify Functions:

- **Basic Functions:** Primary purpose (must be retained)
 - Transport person
 - Steer direction
 - Support rider
 - Stop motion
- **Secondary Functions:** Support the basic functions
 - Provide comfort
 - Show speed

Step 3: Determine Function Hierarchy:

- Higher-level (Why function exists)
- Lower-level (How function is performed)
- **Example:**
 - Why? Transport person → How? Rotate wheels → How? Pedal force

Step 4: Assign Costs to Functions:

- Allocate product cost among functions

- **Example:**
 - Transport person: ₹1,500
 - Steer direction: ₹500
 - Support rider: ₹600
 - Stop motion: ₹400

Step 5: Evaluate Function Worth:

- Estimate minimal cost for each function
- **Example:** Stop motion could cost ₹200 with drum brake instead of disc

Step 6: Analyze Function Gap:

- Compare current cost vs. worth
- **Example:** Stop motion - Current ₹400, Worth ₹200, Gap ₹200

6) How will you do VE for the following product: Bicycle.

VE Study of Bicycle:

Information Phase:

- Functions identified: Transport person, steer, support, stop, etc.
- Cost breakdown:
 - Frame: ₹1,000
 - Wheels: ₹800
 - Brakes: ₹400
 - Gears: ₹500
 - Others: ₹300
 - **Total: ₹3,000**

Creative Phase:

- Generate alternatives:
 - Frame: Steel vs. Aluminum vs. Carbon
 - Brakes: Drum vs. Disc vs. Rim
 - Transmission: Chain vs. Belt vs. Shaft
 - Wheels: Alloy vs. Steel

Evaluation Phase:

- Use criteria: Weight, cost, durability, maintenance
- Score alternatives using decision matrix
- Identify best combos

Development Phase:

- **Selected alternatives:**
 - Frame: Steel (cost-effective, good strength)
 - Brakes: Rim brakes (cheaper, lighter)
 - Wheels: Alloy (better performance)
 - Gears: 6-speed (adequate for basic use)

Value Improvement Proposals:

- **Reduce cost:**
 - Replace disc brakes with rim brakes: Save ₹200
 - Use steel rims instead of alloy: Save ₹300
- **Improve value:**
 - Add lightweight tubes: +₹50, save 1 kg
 - Improved seat comfort: +₹100, better user experience

Implementation:

- New cost: ₹2,500
- Value improved from 0.6 to 0.72

7) Discuss problems and difficulties to implement VE in any industry.**Problems and Difficulties:****1. Organizational Resistance:**

- Employee fear of job loss or change
- Resistance from departments (design, manufacturing)
- Lack of top management support

2. Cultural Barriers:

- Risk-averse culture, fear of innovation
- Silo-based working, poor cross-functional collaboration
- "Not invented here" syndrome

3. Lack of Technical Knowledge:

- Inadequate understanding of VE methodology
- Lack of trained facilitators
- Insufficient knowledge of alternative materials/processes

4. Time Constraints:

- VE studies require time, but production schedules are tight
- Shortage of time for creative and analysis phases
- Accelerated development cycles

5. Cost Considerations:

- Investment needed for training and workshops
- Implementation costs may offset savings initially
- Difficulty in accurately estimating costs

6. Information Gaps:

- Inadequate cost data at component level
- Limited supplier information
- Lack of competitor benchmarking data

7. Implementation Challenges:

- Difficulty converting recommendations to reality
- Supply chain issues with new materials/components
- Quality control concerns

8. Sustainability Issues:

- Short-term focus vs. long-term benefits
- Difficulty measuring intangible values (social, political)

9. Poor Communication:

- Lack of clear objectives and expectations
- Inadequate sharing of VE findings

Solutions:

- Management commitment and leadership
- Comprehensive training programs
- Recognition and reward systems
- Effective project selection criteria
- Phased implementation approach
