1. Which method is commonly used to reduce the need for cores in sand casting?
Answer:
The use of **simplified part geometry** and **design modifications such as parting line adjustment** is commonly employed to reduce the need for cores in sand casting. Specifically, **changing the orientation** of the part in the mold or **redesigning features** to be included in the mold cavity can eliminate the necessity for complex core shapes.

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2. Explain how core requirements can be reduced in sand casting.
Answer:
Core requirements can be reduced by:

- **Modifying part geometry** to eliminate undercuts or internal cavities.
- **Reorienting the part** to a more favorable position within the mold.
- **Combining features** into a single mold cavity instead of separate core insertions.
- **Using design alternatives** such as bosses or ribs instead of hollow sections.
  Reducing cores leads to **lower cost**, **simpler tooling**, and **fewer defects** such as gas porosity or misalignment.

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3. List two aspects of manufacturing processes that are integral to Design for Manufacturing and Assembly (DFMA).
Answer:

1. **Part Reduction** – Minimizing the number of components to reduce complexity and cost.
2. **Ease of Assembly** – Designing parts that are easy to align, insert, and secure during assembly.

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4. Explain why certain fastening methods are more suitable for automated assembly processes. Support your explanation with an example.
Answer:
Fastening methods such as **snap fits, press fits, or self-threading screws** are more suitable for automated assembly because they:

- Require **fewer orientation steps**
- **Reduce tool usage**
- Allow for **quick and repeatable operations**

Example: Snap-fit joints in plastic enclosures are ideal for robotic assembly since they do not need external tools or torque control, unlike screws or bolts.

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5. Identify the factor from the options below that typically leads to increased handling time in manual assembly operations.
Answer:
Factors like **small or non-symmetric parts**, **parts that require reorientation**, or **poor part presentation** increase manual handling time. For instance, if parts are not oriented consistently, the assembler spends additional time adjusting them, thus reducing efficiency.

PART B – (2 × 13 = 26 Marks) + (1 × 14 = 14 Marks)

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6. (a) Explain why minimizing the use of cores is recommended in sand casting processes.
Answer:
Minimizing the use of cores is recommended because:

- **Reduces production cost** – Core making is time-consuming and adds to labor and material costs.
- **Improves dimensional accuracy** – Eliminating cores avoids errors due to core misplacement or deformation.
- **Enhances mold strength** – More homogeneous molds without cores are structurally stronger and less prone to collapse.
- **Reduces defect probability** – Gas defects, inclusions, and core shift-related issues are minimized.

(OR)

6. (b) What is Group Technology, and how can it improve the efficiency of manufacturing operations?
Answer:
Group Technology (GT) is a manufacturing approach that groups similar parts based on geometry, processing, or function into families to be manufactured using a standard process.
Benefits:

- **Reduces setup time and tooling changes**
- **Improves production planning and scheduling**
- **Enables cellular manufacturing**
- **Improves inventory control**
  GT increases **efficiency, flexibility, and quality** while reducing waste and costs.

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7. (a) Describe the general DFMA fastening guidelines and explain how they help in simplifying sensor assembly.
Answer:
DFMA fastening guidelines include:

- **Minimize the number of fasteners**
- **Use standard fasteners**
- **Use self-locating and self-fastening components**
- **Ensure access for assembly tools**
  For sensor assembly, these principles help by:
- Reducing time and error in aligning and mounting the sensor
- Allowing for easy integration using clips or snap-fits
- Improving serviceability and replacement

(OR)

7. (b) How can snap-fits, self-locating features, or modular design be used to reduce or eliminate fasteners in a product design?
Answer:

- **Snap-fits**: Provide secure attachment without tools; ideal for plastics.
- **Self-locating features**: Align parts automatically, minimizing orientation errors.
- **Modular design**: Standardizes sub-assemblies, reducing the need for custom fasteners.
  These features **simplify assembly**, **reduce part count**, and **support automation**.

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8. (a) (i) Apply your understanding of DFMA principles to identify how part count, assembly time, and labor complexity might present challenges in a product like Ford's original dashboard design.
Answer:
Challenges:

- **High part count** increases inventory, tracking, and failure points.
- **Long assembly time** due to multiple small parts and fasteners.
- **Labor complexity** from non-modular layout, difficult access, and multiple connectors.
  This complexity results in **higher cost and greater quality variability**.

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8. (a) (ii) Evaluate the outcomes in terms of cost savings, assembly time reduction, and quality improvements.
Answer:
Outcomes of DFMA in Ford’s redesign:

- **Cost savings** from reduced material, inventory, and labor.
- **Assembly time reduction** via part integration and simplified joints.
- **Improved quality** due to fewer assembly errors, better fitment, and reduced rework.

(OR)

8. (b) Analyze how each step in the DFMA redesign process contributes to improving the manufacturability and assembly of a truck dashboard assembly.
Answer:

1. **Part Consolidation**: Reduces part number and interfaces.
2. **Simplified Fastening**: Use of clips and snap-fits speeds up assembly.
3. **Modular Sub-assemblies**: Enhances parallel processing and repairability.
4. **Improved Accessibility**: Allows tool access and cable routing.
5. **Material Optimization**: Chooses materials for molding and lightweighting.
   Each step leads to **cost reduction**, **higher efficiency**, and **better ergonomics** during manufacturing and service.