WELCOME TO THE COURSE

MANUFACTURING PROCESSES
(TA-202)

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Contents

- Preliminary Information.
- History of manufacturing.
- What is manufacturing?
- Issues related to design and manufacturing: material, aesthetic, production
- Design for manufacture
- Material selection: properties consideration
- Classification of manufacturing processes
- Selection of manufacturing processes
- Assembly and design for assembly
- Quality, TQC, automation, computer application
### LECTURE-WISE BREAK-UP:

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### COURSE POLICIES

**Marks distribution:** (i) Laboratory + project = 50% (-5%), (ii) Theory examination = 50% (+ 5%). It is to be noted that the (i) questions related to laboratory exercises will be a part of the theory exams. with an overall weightage of 5%. There will be no separate quiz.

### ACADEMIC DISHONESTY

**FOR CHEATING IN THE EXAMINATION HALL:** ZERO TOLERANCE ➞ **“F” GRADE FOR URE**

**PLEASE NOTE IT CAREFULLY**

THEORY CLASS ATTENDANCE HAS NO MARKS BUT LAB. ATTENDANCE HAS CERTAIN WEIGHTAGE ALREADY INFORMED THROUGH E-MAIL AND UPLOADED ON THE SITE. PLEASE NOTE THAT THERE IS ALWAYS A GOOD, POSITIVE AND ALMOST LINEAR CORRELATION BETWEEN ALPHABETIC GRADE AND ATTENDANCE.

**NO MAKE-UP WILL BE CONSIDERED UNLESS THE STUDENT HAS AUTHORIZED LEAVE REALLY FOR UNAVOIDABLE SITUATIONS. A STUDENT SEEKING A MAKE-UP IS USUALLY AT DISADVANTAGE.**
ADVANCED MACHINING PROCESSES  BY V.K JAIN ,  ALLIED PUBLISHERS, NEW DELHI (2002)

INTRODUCTION TO MICROMACHINING , V.K.JAIN (EDITOR) PUBLISHED  BY NAROSA PUBLISHERS, NEW DELHI (2009)

NON- CONVENTIONAL MATERIAL REMOVAL PROCESSES  BY V.K.JAIN, BLOCK-4, INDIRA GANDHI NATIONAL OPEN UNIVERSITY (IGNOU), NEW DELHI


Reference Books

Activity Roster for Lab-work

Lab Training first five turns:
#Turning (1 Turn), #Milling and Shaper (1 Turn), #Drilling Fitting (1 Turn), #CNC demonstration and job design (1 Turn), #CNC practice (1 Turn)

I First turn : Project groups should be formed. (Emphasize in class)
II Second turn : Project groups name should be given to the tutor.
III Third turn : Project discussion with Technical Staff / Guide with Material List.
IV 4th to 5th turn : Everything should be finalized during the 4th to 5th lab turn. So the work should start without any loss of time on the 6th lab turn.

• For getting ‘D’ or better letter grade in this course, one should score total marks ≥ 35 %, and ≥ 25 % in theory that is out of 55% (=14 marks).

• Students are advised to keep their mobiles in the switch off mode that is they are not supposed to use their mobiles strictly in the Lecture Class as well as in the Lab. class (especially when working on the machines in the Lab.).
Production of the articles made of wood, stone, ceramic etc. (5000-6000 B.C.)

Initially hammering and casting for production.

Ornamental objects: Gold, copper, iron.

Major breakthrough: production of steel A.D. 600-800.


Till industrial revolution (1750): batch production (no two parts made exactly alike).
For two matching parts (M & F) made at two different places/plants/countries: nut & bolt *would not fit*

What do you need??

**Standardization/ Interchangeability**

*(Example: Easy to replace a broken bolt of a certain size with an identical one purchased years later)*

With enhanced automation (automatics, computer control etc.): production rate has gone up.

*Ex: Ten Al. beverage cans/s, cutting speeds: 125 m/s, screw & bolts: thousands/min.*
WHAT IS VALUE ADDITION?

- Price of clay: Rs. 1/kg
- Price of a dinner (ceramic) plate - Rs. 50/piece (200 g)
- Clay has gone a number of changes to be as a dinner plate
- See the objects around you: fan, chair, pen, etc.
  - had different shapes at one time.
  - not found in nature as they appear.
  - most of these products/objects (made of a combination of several parts made of a variety of materials).

Manufacturing (Latin word): Manu + factus: Made by hands.

Present perspective: Involves making products from raw material by various processes, machinery, & operations following a well organized plan for each activity required.

Process Plan for a part
Manufacturing backbone of any industrialized nation.
Related to the economic health of a country.
Higher the level of manufacturing activity : higher the standard of living (Japan, U.K, China, etc.)
Machine Tools: (ex- Lathe m/c, presses, milling m/c etc)

Some objects made of a combination of several parts, made from a variety of materials (ex- bicycle, computer, car: 15000 parts etc)
Manufacturing is a complex activity that involves: people, machinery, tooling with various levels of automation (computers, robots, AGV etc) etc.
CONTRIBUTION OF MANUFACTURING TO GDP
- Meet design requirement (Diameter, length, surface finish, tolerances, etc.).

- Most economic method to minimize cost

- From design to assembly: the quality should be built into the product at each stage.

- Production method should be flexible: meet varying demand (quantity, types, delivery date, etc.).

Manufacturing Organization: strive for higher productivity and optimum use of all its resources → material, men, machines, money (4M).
Important issues related to Design and MANUFACTURING.

Ex: Paper clip (clip shape: square or round, wire size: dia, length)

Functional requirement: to hold papers with sufficient clamping force.

Material issues:
- Type of material. Stiffness (deflection/force) & strength (yield stress: stress to cause permanent deformation. If it is too strong, a lot of force will be required but if it is too weak, it may not work in holding the papers etc.).

Aesthetic issues:
- Style, appearance and surface finish of the clip. Corrosion resistance is also required (subjected to moisture and other environmental attack).

Production issues:
- Quantity to be produced: tens, hundreds, ...., millions
- Can the wire be bent without cracking/breaking?
- Smooth edge or burr (undesirable): paper finger.

1. YOU CAN NOT MAKE IF YOU CAN NOT MEASURE.
2. YOU CAN NOT DESIGN IF YOU CAN NOT MANUFACTURE.
WHAT IS MANUFACTURING?

IN CASE OF METALLIC PARTS, STEPS FOLLOWED

ORE→ EXTRACT METAL→ MELT IN A FURNACE→ CASTING→ CUT IN PROPER SIZES (LOG)→ TRANSPORT TO TRADER

What has gone into?
• Value addition
• Conversion of raw material into useful product → Manufacturing by performing different operation

Final product: Weight 3 kg, Cost – Rs 500/=.

RAW MATERIAL COST Rs. 60/= PER Kg.
CLASSIFICATION OF VARIOUS MANUFACTURING PROCESSES

❖ PRIMARY FORMING PROCESSES (ADDITIVE OR ACCRETION)
  • CASTING AND MOULDING PROCESSES
  • POWDER METALLURGY, RAPID PROTOTYPING

❖ DEFORMING PROCESSES (FORMATIVES)
  • HOT WORKING
  • COLD WORKING
    (FORGING, ROLLING, WIRE DRAWING, ETC.)

❖ MATERIAL REVOAL PROCESSES (SUBTRACTION)
  • CONVENTIONAL (TURNING, MILLING, ETC.)
  • ADVANCED MACHINING PROCESSES (ECM, EDM, LBM, ETC.)

❖ JOINING AND FABRICATION PROCESSES (ASSEMBLY)
  • WELDING, REVETTING, BRAZING, SOLDERING, ETC.

❖ FINISHING AND SURFACE TREATMENT PROCESSES
  • BURR REMOVAL (DEBURRING)
  • MECHANICAL CLEANING AND FINISHING
  • CHEMICAL CLEANING
  • COATING
  • VAPOUIZED METAL COATING

❖ HEAT TREATMENT OR BOLK PROPERTY ENHANCEING PROCESSES
  • HARDENING
  • DECTILITY, TOUGHNESS AND MACHINABILITY
  • STRENGTHENING
MICROFABRICATION IS GOING TO WITNESS AN EXCELLENCE IN R & D AT A REMARKABLE RATE
MACHINING METHODS

TRADITIONAL
- Turning
- Milling
- Drilling
- Grinding

ADVANCED
- Mechanical
  - AJM
  - USM
  - AWJM
  - AFM, MAF, M-RAFF, MPF
- Thermal
  - EDM
  - EBM
  - LBM
  - PAM
- Chemical
  - ECMM
  - PCMM

HYBRID
- ECSM
- ECG
- EDG
- ELID, etc
Every designed product should be possible to make as a real product. If so, design and manufacturing both are interrelated.

- Design a part such that it meets: Functional requirements, Manufacturing requirements, possible to manufacture with ease and economy.

![Designed Part]

Aspect Ratio = 200/0.5 = 400

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SOME QUESTIONS TO CONSIDER?

- How to Manufacture a so high aspect ratio product?
- Will it be economical?
- Can you change the design to make it viable to manufacture economically?
Hence designer should be well acquainted with?

- Materials and their properties
- Manufacturing processes & capabilities
- Related Manufacturing machines & equipments
- Assembly and inspection procedures

- General types of materials: Iron and steels, Non-ferrous metals and alloys, Plastics, polymers, Ceramics, glasses, diamonds etc., Composite materials
Finishing and surface treatment processes:
- Burr removal (deburring),
- Mechanical cleaning and finishing,
- Chemical cleaning,
- Coating, Vaporized metal coating
- Heat treatment or bulk property enhancing processes
  - Hardening
  - Ductility, toughness and machinability
  - Strengthening

Hence designer should be well acquainted with?
What about stresses $S_1$ and $S_2$?
Are they equal or different when the block just starts cutting?
Shaping

Planing

Milling (slab)

Milling (face)

Facing

Abrasive machining

Drilling

Turning

Broaching
Quantity to be produced (small, medium, large).

Shape to be produced (circle, square, rectangle etc.).

Material & its properties.

Metal or non-metal; electrical conductivity, light reflecting or not,... brittle/ hard/ soft, magnetic / non-magnetic

Dimensional and surface finish requirements

tolerance \(10^{0.02} \pm 0.02\) \(10^{\pm 1}\), fits (roughness value), surface finish

\[ R_{\alpha} = 1 \text{ \(\mu\)m} \quad R_{\alpha} = 0.1 \text{ \(\mu\)m} \quad R_{\alpha} = 0.01 \text{ \(\mu\)m} \]

Cost: (selected mfg. process)

What will happen if selected material & mfg. process are improper? Rejection / Failure of the part.
The product will fail.

- When will call it failed?
  - Stops functioning.
  - Does not function properly.
  - Becomes unreliable or unsafe.
Assembly requires consideration of putting parts together.

**Ways of assembly:**

- **Manual**
- **Automatic equipment**
  - Ex: hand driven screw driver & electric driven (Semi Automatic)
  - **Permanent** → adhesive → aircraft & automobile
  - Riveting
  - Welding
  - Brazing
  - Soldering
- Separation is possible by damaging the joined parts.

**Temporary**

- Rivets → Aero plane wings, river bridges (old), etc.
- Nut & bolt (+ washer) Requires preparation of holes → drilling(reduce part life)/punching
- Separation is possible by damaging the joined parts.
Design For Assembly

- Important area of manufacturing.
- Permit assembly with ease.
- Reduce cost of assembling

Simplify design by reducing required no of pieces / parts.
AN EXAMPLE OF DESIGN FOR ASSEMBLY:
(A) AS DESIGNED, THIS PRODUCT CONSISTS OF MANY COMPONENTS AND TAKES CONSIDERABLE TIME TO ASSEMBLE.
(B) REDESIGNED PRODUCT CONSISTS OF ONLY TWO PARTS AND IS EASY TO ASSEMBLE, EITHER BY HAND OR IN AUTOMATED MACHINERY.
Most important aspect of manufacturing.
- Influences marketability & customer satisfaction.
- **High quality and low cost:**
  - Quality also mean meeting design specifications.
  - Quality must be built into a product → from the design stage through all subsequent stages of manufacturing & assembly.

**Total quality control**
Quality also means meeting design specifications of the product.
- **Customer satisfaction:** Are they happy with the quality and price?

No: to capture the market, customer should be delighted.

*CUSTOMER SHOULD NOT BE SATISFIED ONLY, S/HE SHOULD BE DELIGHTED BY QUALITY.*
Why Automation?

- Improved productivity
- Improved quality
- Minimum cycle time
- Reduced labor cost / hazard
ROLE OF THE COMPUTERS IN MANUFACTURING

- Computer control of manufacturing processes: NC/CNC/DNC
- Optimization of mfg. processes
- Automated material handling system (AGV)
- Automated inspection and testing
- Automated assembly systems
- Robots in manufacturing
  - Reduced human error
  - Better quality control
Involvement of computer in various phases of Manufacturing and sharing the common database

- CNC (Computer Numerical Control) part program
- Computer integrated manufacturing (CIM)
- Computer aided design (CAD)
- Computer aided process planning (CAPP)
- Flexible Manufacturing System (FMS)
A CONVENTIONAL MACHINE'S SLIDE IS MOVED BY AN OPERATOR BY TURNING THE HANDWHEEL. ACCURATE POSITIONING IS ACCOMPLISHED BY THE OPERATOR.

THE SAME PART CAN BE MADE BY NC OR MANUAL MACHINING. THE INCREASED COST OF NC CAN BE OFFSET BY THE DECREASED MANUFACTURING TIME AND IMPROVED QUALITY.

IN N.C. → FEED (f), D.O.C. (d); → CUTTING SPEED (V) → CONTROLLED THROUGH NC PART PROGRAM.

NC / CNC ADVANTAGES:
• BETTER QUALITY
• HIGHER PRODUCTIVITY
• LOWER REJECTION
• FACTORY OF FUTURE
• REDUCED INSPECTION

• CARDS / PAPER TAPE
• MAGNETIC TAPE
• FLOPPY / CD

MANUAL MACHINING - FEED, D.O.C.; V SET BY OPERATOR
ERROR, APPROXIMATION, SKILL OF OPERATOR
NUMERICAL CONTROL - THE NC MACHINE TAKES THE PROGRAMMED POSITION FROM A PART PROGRAM TAPE – ANY DIFFERENCE BETWEEN THE COMMANDED POSITION AND THE FEEDBACK SIGNAL READING WILL GENERATE A SIGNAL FROM THE MCU TO RUN THE DRIVE MOTOR IN THE PROPER DIRECTION TO CANCEL ANY ERRORS.
THANK YOU