Introduction

Machining is the process of removing unwanted material from a workpiece in the form of chips to obtain a finished product of the desired ________, ________, and ________.

Machining is the most important of the basic manufacturing processes.

Vast majority of manufactured products require machining at some stage in their production.

7 Basic Chip Formation Processes

- Shaping / Planing
- Turning
- Milling
- Drilling
- Sawing
- Broaching
- Grinding (Abrasive Machining)
Machining Inputs & Outputs

Fundamental Cutting Parameters
For all metal cutting processes it is important to distinguish between:

- ______________ - Primary cutting motion and relates to velocity of workpiece relative to cutting tool (sfpm, in/min, m/m, m/sec)
- _________ - Amount of material removed per revolution or per pass of tool over workpiece (in/rev, in/cycle, in/min, in/tooth)
- ______________ - Distance tool engages workpiece

Basic Components for Machining
4 Basic components that makeup any machining process

- Machine Tool or Machining Center
- Workpiece
- Workholding Device

Process Input Parameters

General guidelines are available in many types of reference handbooks
Factors that must be considered to machine a given material
• Cutting Speed, Depth of Cut, Feed Rate
• Process
• Material Type & Hardness
• Cutting Tool Material & Geometry

Machining Reference Data Example

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Process Cycle Times

Determined using standard formulas based on type of process and recommended machining values for a particular type of material
• Material Removal Rate (MRR) - Volume of material removed over time
• Cutting Time (Tc) - Time required to perform cut

Example
Turning Process Cycle Times

\[ MRR = \frac{\text{Volume of Cut}}{\text{Cutting Time}} \]

\[ T_c = \frac{L + \text{Allowance}}{f \cdot n_s} \]
Chip Formation

Chip formation is generally explained using a 2-dimensional (orthogonal) model rather than a 3-dimensional (oblique) model.

Chip formation is based on a localized _____ process taking place over a narrow region.

Machining Models

Machining models allow for understanding of:
• Behavior of the material during chip formation
• Influence of the most critical elements of the tool geometry
  • Edge Radius (Nose Radius)
  • Back Rake Angle
• Interactions between the tool face & chip surface
• Interactions between the tool flank & material surface

Effects of Work Material Properties

Properties of the workpiece are important in chip formation:
• High strength materials require larger forces which increase deflection, friction, heat generation, operating temperature and require greater work input.
• Structure and composition such as hard or abrasive constituents affect tool wear.
• _____ is important in determining type of chip produced
  • Continuous
  • Discontinuous (Segmented)
Heat & Temperature in Metal Cutting

Power put into the process is largely converted to heat, which elevates the temperature of the:
- Chip
- Workpiece
- Tool
- Environment / Cutting Fluid

Three main sources of heat:
- Shear Zone - Plastic deformation
- Tool / Chip Interface Contact Region - Plastic deformation & friction
- Tool Flank - Friction

Types of Machining Operations

Machining Cylindrical Surfaces
- Turning
- Drilling
- Grinding
- Sawing

Machining Flat Surfaces
- Broaching
- Sawing

Machining Holes
- Drilling
- Boring
- Reaming
- Grinding
Chapter 21 - Fundamentals of Chip-Type Machining Processes

- Basic understanding of chip formation processes and major components of the process
- Basic concept of chip formation
- Effects of work material properties
- Effects of heating and temperature in metal cutting

Review Questions: ____________________________
________________________________________________________________________________________________