مقدمه ای بر درس روشهای تولید

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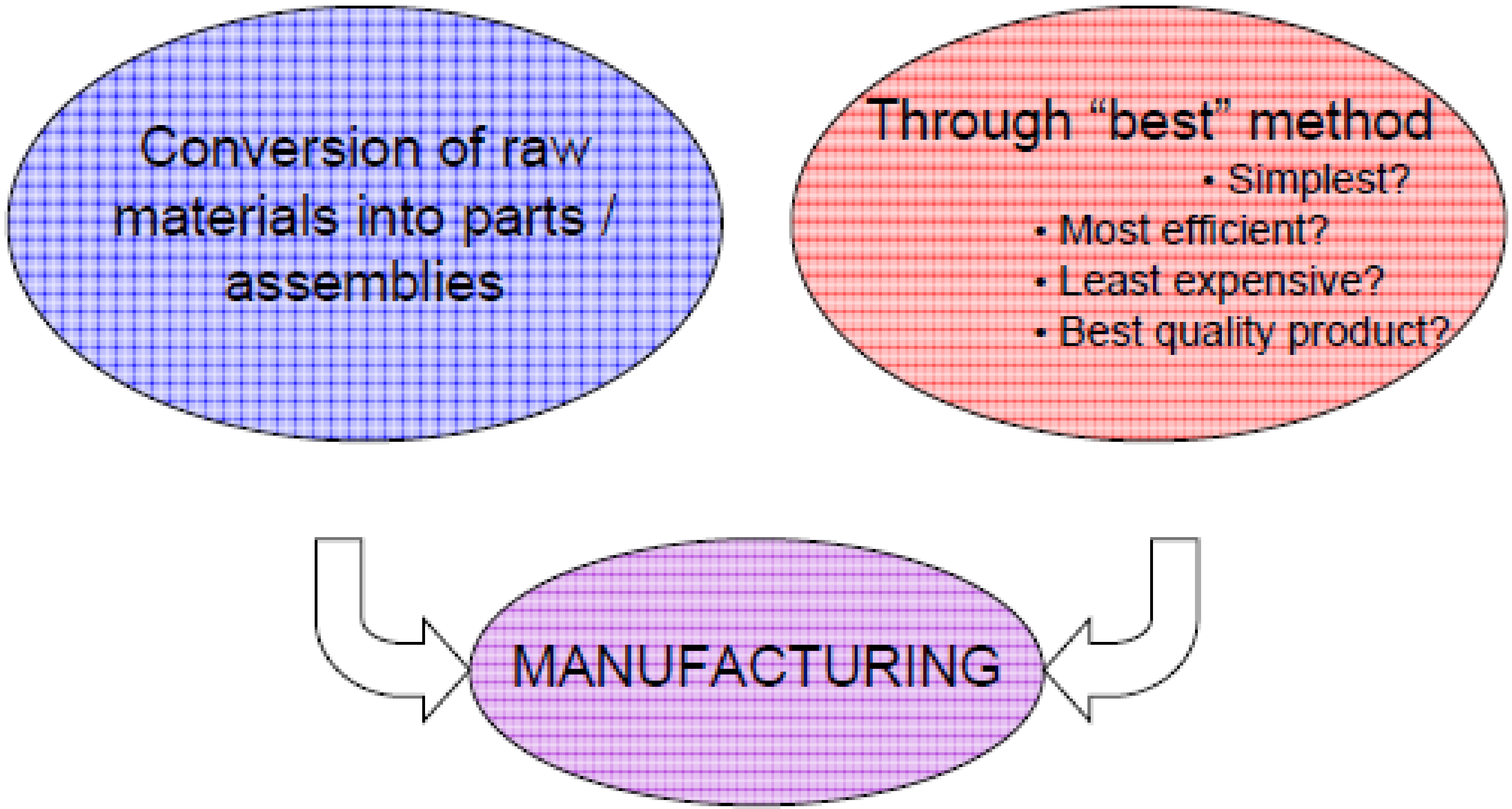
Definition of Manufacturing

MANUS + FACTUS = MANUFACTURING

hand + make = hand-made

- But today, automation dominates!

Definition of Manufacturing



Difference between Manufacturing and Fabrication

Manufacturing refers to making end products for use or sale from raw materials, either by hand or with the help of machines.

In English, Fabrication refers to making raw materials usable for manufacturing. For example, cotton is woven into a fabric; metals are cut, forged, bent, stamped, shaped or welded; rubbers and plastics are extruded, molded or calendered, etc.

Fabricated products are usually intermediate products, but they can also be end products (i.e. manufactured products!)

Definition of Manufacturing Engineer

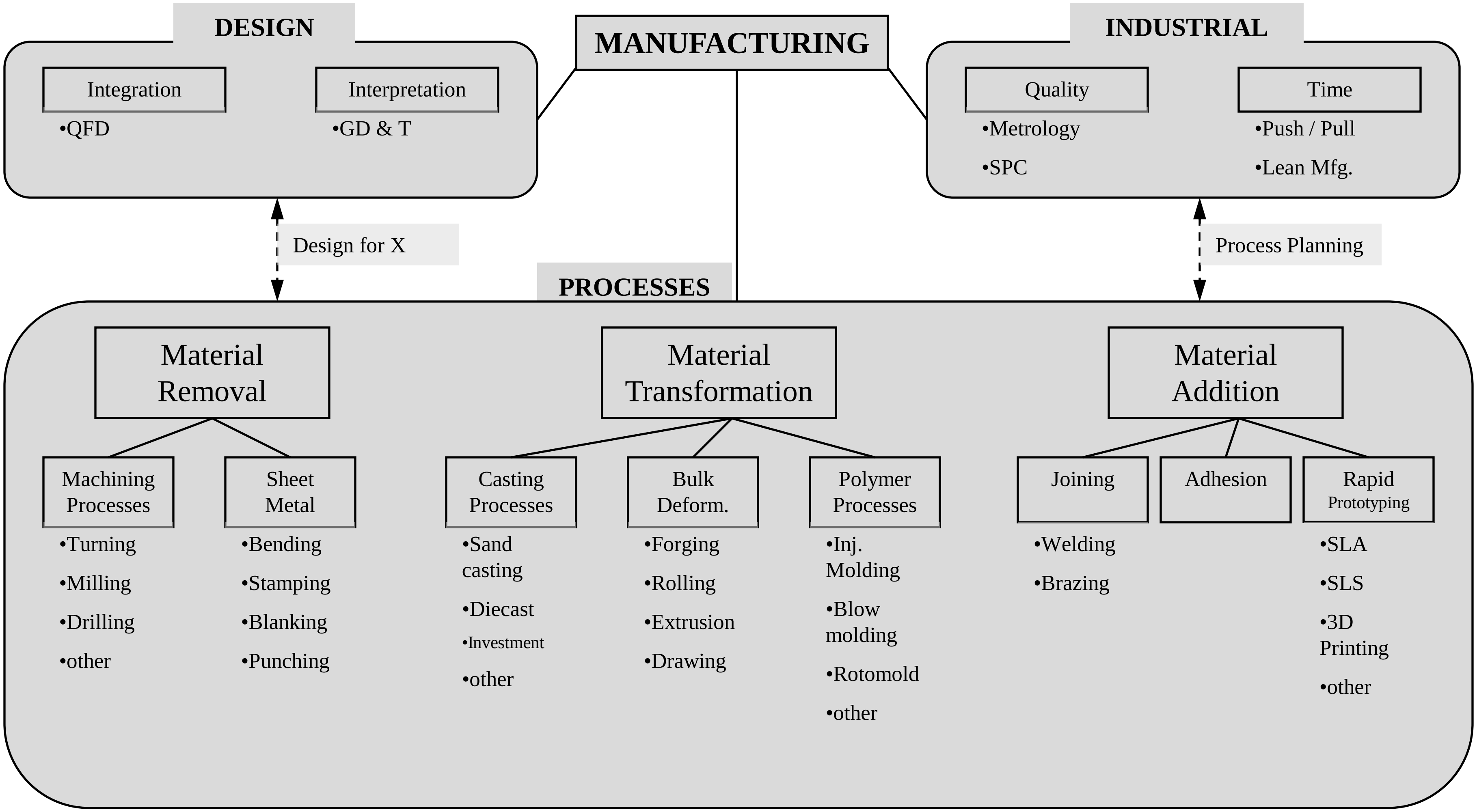
The function of Manufacturing Engineer is:

To determine and define the equipment, tools and processes required to convert the design of the desired product into reality in an efficient manner.

Requires knowledge and couples optimization of

- Materials
- Processes
- Equipment

نقشه راه


DESIGN
Integration
•QFD
Interpretation
•GD & T
MANUFACTURING
INDUSTRIAL
Quality
•Metrology
•SPC
Time
•Push / Pull
•Lean Mfg.
Design for X
Process Planning
PROCESSES
Material Removal
Machining Processes
•Turning
•Milling
•Drilling
•other
Sheet Metal
•Bending
•Stamping
•Blanking
•Punching
Material Transformation
Casting Processes
•Sand casting
•Diecast
•Investment
•other
Bulk Deform.
•Forging
•Rolling
•Extrusion
•Drawing
Polymer Processes
•Inj. Molding
•Blow molding
•Rotomold
•other
Material Addition
Joining
•Welding
•Brazing
Adhesion
Rapid Prototyping
•SLA
•SLS
•3D Printing
•other

Review: Fluid and Heat Transfer

Fluids Application:

- Turbulence – Reynold’s Number
- Energy – Bernoulli Equation
- Conservation – Continuity Equations

Reynols' Number

- Dimensionless characteristic that helps determine *type* of flow
  - Laminar
  - Turbulent
- Ratio of inertial force to viscous force

$$\mathrm{Re} = \frac{\rho v D}{\mu} = \frac{(density)(velocity)(characteristic\ length)}{absolute\ viscosity}$$

- Characteristic length can be diameter, length, hydraulic diameter,…

- Re < 2100 ~ laminar (pipe flow)
- Re > 4000 ~ turbulent
- Re > 10000 ~ fully-developed turbulent

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Viscosity

Viscosity is a measure of a fluid's resistance to flow

- Absolute viscosity $\mu\left[\frac{lbf\text{ - }sec}{ft^2}\right], [Pa-s]=\left[\frac{N-s}{m^2}\right]$

- Kinematic viscosity $\nu\left[\frac{ft^2}{\sec}\right], \left[\frac{m^2}{s}\right]$

- Relationship $\nu=\frac{\mu}{\rho}=\left[\frac{N-s}{m^2}\right]\left[\frac{m^3}{kg}\right]\left[\frac{kg-m}{N-s^2}\right]=\left[\frac{m^2}{s}\right]$ Stoke

Bernoulli Equation

The Bernoulli Equation can be considered to be a statement of the conservation of energy principle appropriate for flowing fluids. The qualitative behavior that is usually labeled with the term "Bernoulli effect" is the lowering of fluid pressure in regions where the flow velocity is increased.

- Balance of fluid energy between analysis points
- Typically used to calculate flow velocity
- Assumes
  - incompressible fluid
  - lumped friction
  - no thermal changes (no heat losses)
- Equates pressure, kinetic and potential energies
- For fluid flowing from point 0 to point 1:

$$P_0 + \frac{\rho v_0^2}{2} + \rho g h_0 = P_1 + \frac{\rho v_1^2}{2} + \rho g h_1 + h_f$$

Bernoulli Equation

Example: A water tank drains freely 100 ft below its free surface through a 3 –in pipe. What is the discharge velocity?

Answer: 80.2 ft/s

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Continuity Equation

- Conservation of mass flow

$$\rho_0 A_0 v_0 = \rho_1 A_1 v_1$$

- Assume no thermal effects

$$A_0 v_0 = A_1 v_1$$

(volumetric flows equivalent)

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HEAT TRANSFER

Specific Heat

- Amount of energy needed to raise 1 mass of material by 1 degree
- Intrinsic property

$$c_p \left[\frac{J}{kg - {}^\circ C} \right]$$

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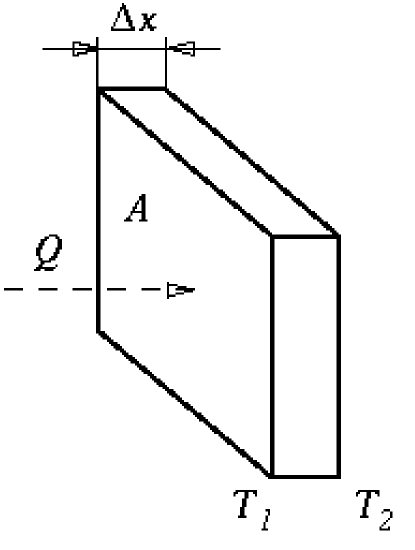
Thermal conductivity

In physics, **thermal conductivity** (often denoted *k*, *λ*, or *κ*) is the property of a material to conduct heat.

$$k = \frac{Q\Delta x}{A(T_2 - T_1)}$$



Thermal Diffusivity

- Ratio of thermal conductivity to heat capacity
- Ability to conduct energy wrt ability to store it
- Higher TD = quicker response to temp changes

$$\alpha = \frac{k}{\rho c_p}$$

Heat Transfer Mechanisms

- Conduction
- Convection
- Radiation

Conduction

- Fourier's Law (1-D conduction)

$$Q_{1-2} = q_{1-2}A = \frac{kA}{L}(T_1 - T_2)$$

$$Q \equiv overall\ heat\ transfer\ rate\left[W\right]$$

$$q \equiv specific\ heat\ transfer\ rate\left[\frac{W}{m^2}\right]$$

$$A \equiv heat\ transfer\ area\left[m^2\right]$$

$$k \equiv thermal\ conductivity\left[\frac{W}{m-K}\right]$$

$$L \equiv thickness\left[m\right]$$

$$T \equiv temperature\left[K\right]$$

Convection

- Based on *film coefficient* h

$$Q_{1-2} = q_{1-2}A = hA\left(T_s - T_\infty\right)$$

$$Q \equiv overall\ heat\ transfer\ rate\left[W\right]$$

$$q \equiv specific\ heat\ transfer\ rate\left[\frac{W}{m^2}\right]$$

$$A \equiv heat\ transfer\ area\left[m^2\right]$$

$$h \equiv film\ coefficient\left[\frac{W}{m^2 - K}\right]$$

$$T \equiv temperature\left[K\right]$$

- h rarely known to great accuracy

Radiation

Thermal radiation is electromagnetic radiation generated by the thermal motion of charged particles in matter. All matter with a temperature greater than absolute zero emits thermal radiation.

- Stefan-Boltzmann emissive power

$$E_{black} = \sigma\left(T_1^4 - T_2^4\right)$$

$$E_{black} \equiv black\ body\ (ideal)\ emissive\ power \left[\frac{W}{m^2}\right]$$

$$\sigma \equiv Stefan - Bolzmann\ constant$$

$$= 0.1713 \cdot 10^{-8}\ Btu / hr - ft^2 - {}^\circ R^4$$

$$= 5.67 \cdot 10^{-8}\ W / m^2 - K^4$$