Why consider manufacturing? In modern engineering curricula it has sometimes been fashionable to think that manufacturing processes are irrelevant or something to be left to manufacturing specialists. This is an erroneous belief.

But if it can’t be built, … It won’t work. If it can’t be built economically, … It won’t be sold. The manufacturing cost usually control product costs.

The primary manufacturing processes are:
- Casting
- Deformation
- Cutting/machining
- Particulate techniques
- Heat/surface treatments
- Joining and
- Assembly.

Cost of a product is usually be controlled by the cost of manufacturing. Knowledge of manufacturing applied during the design process can greatly reduce the number of design iterations that must be made before the product goes to the end user. Many horror stories relative the manufacturing problems arising from design errors.

Most machines and their parts are made by more than one of these processes. Similar outcomes can come from different manufacturing process.
**Manufacturing Process**

The selection of the appropriate process may depend on the...
- Material
- Relative cost of the processes
- Number of units to be made,
- Maintenance
- Durability
- Reliability and
- Aesthetics.

**Casting**

Materials maybe in a liquid state as a result of high temperatures, like:
- Cast iron,
- Steel,
- Bronze,
- Aluminum,
- Glass, and
- Some plastics.

**Casting**

Other materials are liquid because the chemical components have not reacted and solidify as the reaction goes to completion, like:
- Concrete
- Some plastics, and
- Resins.

**Deformation**

Cold forming operations include:
- Punching,
- Bending,
- Shearing and
- Rolling of the material.

**Deformation**

Hot forming operations include:
- Forging,
- Extrusion and
- Drawing.

**Cutting/Machining**

Cutting and machining operations include:
- Drilling,
- Turning (lathe),
- Milling,
- Tapping,
- Grinding,
- Shaving,
**Cutting/Machining**
- Polishing,
- Sawing and
- Planing.

**Particulate Forming**
- Particulate techniques include:
  - Sintering,
  - Spattering, and
  - Diffusion.

**Heat/Surface Treating**
- Typical surface treatments include:
  - Painting,
  - Plating,
  - Coating,
  - Peening,
  - Carburizing,
  - Quenching,

**Heat/Surface Treating**
- Annealing,
- Tempering and
- Anodizing.

**Joining**
- Parts may be joined by:
  - Nailing,
  - Stapling,
  - Riveting,
  - Gluing,
  - Welding,
Assembling

- Assembly is much like joining, but on a larger scale.

Manufacturing Costs

- Manufacturing cost is the primary driver in the selection of the manufacturing process.
- Manufacturing cost increases with the complexity of the manufactured object.
- So the key to cost reduction lies within simplification and efficiency.
- Be aware, there is a threshold that a designer must choose. Some manufacturing simplifications will lead to maintenance or operation complexities.

Manufacturing Costs

- Manufacturing cost increases with the level of precision to which an object.
- Generally, reducing the manufacturing tolerances by half will double the cost of the process.
- If that increased precision does not contribute in some significant way to the performance of the part, that money is wasted.

Manufacturing Costs

- Manufacturing cost generally decreases with volume of production of an object.
- Design, overhead and tooling costs are distributed over more units, so the cost of each unit falls.

Manufacturing Costs

- Manufacturing costs are also decreased by standardization of parts.
- Even for single unit products, the standardization of components spreads the cost of tooling.
- As standardized components become commodities, suppliers must price them competitively, to the advantage of the OEM and the end user.

Manufacturing Costs

- Standardization also reduces part inventories and simplifies maintenance and repairs.
The best way to manufacture a given object may vary greatly.

It depends on the available manufacturing capability.

It depends greatly on suppliers.

“If the only tool that you have is a hammer, all solutions to problems become nails.”

Since quantity of production can often make a difference, increased sales and marketing effort may be as important as increased manufacturing capability.

“For a successful technology, reality must take precedence over public relations, for nature cannot be fooled.”

—Richard P. Feynman