UNIT 1

BASIC PRINCIPLES OF DESIGNING FOR ECONOMICAL PRODUCTION

General design principles for manufacturability

- Strength and mechanical factors
- Evaluation method

Process capability - Feature tolerances

- Geometric tolerances
- Assembly limits
- Datum features
- Tolerance stacks

BASIC PRINCIPLES OF DESIGNING FOR ECONOMICAL PRODUCTION

1. **Simplicity**

- product with the fewest parts
- the least intricate shape
- the fewest precision adjustments
- the shortest manufacturing sequence will be the least costly to produce

2. **Standard materials and components**

- Use of widely available materials
- off the-shelf parts enables the benefits of mass production to be realized by even low
- unit quantity products
- simplifies inventory management
- eases purchasing
- avoids tooling and equipment investments
- speeds the manufacturing cycle

3. Standardized design of the product itself

- When several similar products are to be produced, specify the same materials, parts and subassemblies for each as much as possible.

4. Liberal tolerances: The higher costs of tight tolerances stem from factors such as

(a) extra operations such as grinding, honing, or lapping after primary machining operations

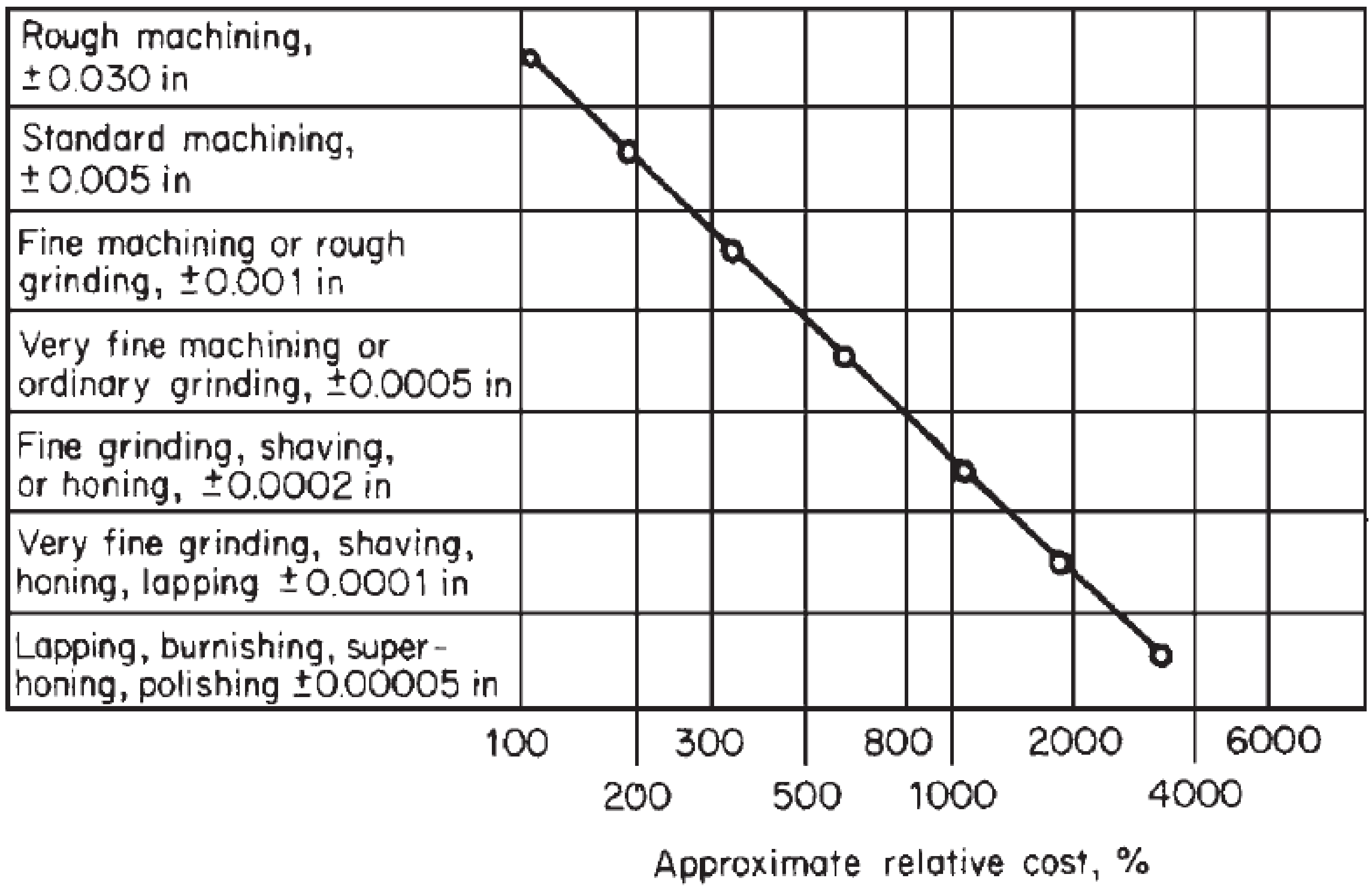
(b) higher tooling costs from the greater precision needed initially when the tools are made and the more frequent and more careful maintenance needed as they wear

(c) longer operating cycles

(d) higher scrap and rework costs

(e) the need for more skilled and highly trained workers
(f) higher materials costs

(g) more sizable investments for precision equipment.


Rough machining, ±0.030 in
Standard machining, ±0.005 in
Fine machining or rough grinding, ±0.001 in
Very fine machining or ordinary grinding, ±0.0005 in
Fine grinding, shaving, or honing, ±0.0002 in
Very fine grinding, shaving, honing, lapping ±0.0001 in
Lapping, burnishing, super-honing, polishing ±0.00005 in
100
200
300
500
800
1000
2000
4000
6000
Approximate relative cost, %

Cost of producing surface finishes

Surface symbol designation	Surface roughness, μin	Approximate relative cost, %
Case, rough-machined	250	100
Standard machining	125	200
Fine machining, rough-ground	63	440
Very fine machining, ordinary grinding	32	720
Fine grinding, shaving, and honing	16	1400
Very fine grinding, shaving, honing, and lapping	8	2400
Lapping, burnishing, superhoning, and polishing	2	4500

Source: N. E. Woldman, *Machinability and Machining of Metals*, McGraw-Hill, New York. Used with the permission of McGraw-Hill Book Company.

5. Use of the most processible materials

There are often significant differences in processibility between conventional material grades and those developed for easy processibility which are,

cycle time

optimal cutting speed

flowability, etc

In the long run, the most economical material is the one with the lowest

combined cost of materials, processing, and warranty and

service charges over the designed life of the product.

6. **Teamwork with manufacturing personnel**

The most producible designs are provided when the

- designer and manufacturing personnel
- particularly manufacturing engineers
- work closely together as a team or otherwise collaborate from the outset.

7. Avoidance of secondary operations

- Consider the cost of operations
- design in order to eliminate or simplify them whenever possible.
- The operations such as deburring, inspection, plating and painting, heat treating, material handling, and others may prove to be as expensive as the primary manufacturing operation and should be considered as the design is developed.

8. Design appropriate to the expected level of production

The design should be suitable for a production method that is economical for the quantity forecast.

For example, a product should not be designed to utilize a thin-walled die casting if anticipated production quantities are so low that the cost of the die cannot be amortized.

Conversely, it also may be incorrect to specify a sand-mold aluminum casting for a mass-produced part because this may fail to take advantage of the labor and materials savings possible with die castings.

9. Utilizing special process characteristics

Wise designers will learn the special capabilities of the manufacturing and take advantage of them.

For example, they will know that injection-molded plastic parts can have color and surface texture incorporated in them as they come from the mold, that some plastics can provide “living hinges,” that powder-metal parts normally have a porous nature that allows lubrication retention and obviates the need for separate bushing inserts, etc.

Utilizing these special capabilities can eliminate many operations and the need for separate, costly components.

10. Avoiding process restrictiveness

On parts drawings, specify only

- the final characteristics needed
- do not specify the process to be used.
- Allow manufacturing engineers as much latitude as possible in choosing a process that produces the needed dimensions,
- surface finish, or other characteristics required.

REFERENCE BOOKS

1. Karl T. Ulrich, Ateven D. Eppinger (2003), Product Design and Development, Tata McGraw-Hill, ISBN- 978-0-070-58513-3.
2. James G. Bralla (1986), Hand Book of Product Design for Manufacturing, McGraw Hill co, ISBN- 978-0-071-50178-1.