

FIGURE 2.1

Survey of designers' knowledge of manufacturing processes. (Adapted from Bishop, R. *Huge Gaps in Designers' Knowledge Revealed*, Eureka, October 1985.)

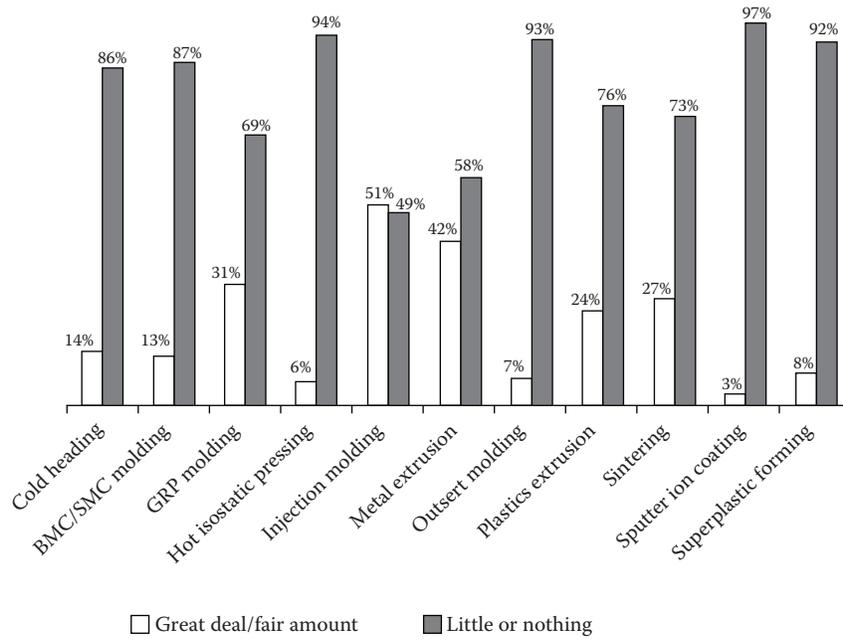


FIGURE 2.2

Survey of designers' knowledge of polymer materials. (Adapted from Bishop, R. *Huge Gaps in Designers' Knowledge Revealed*, Eureka, October 1985.)

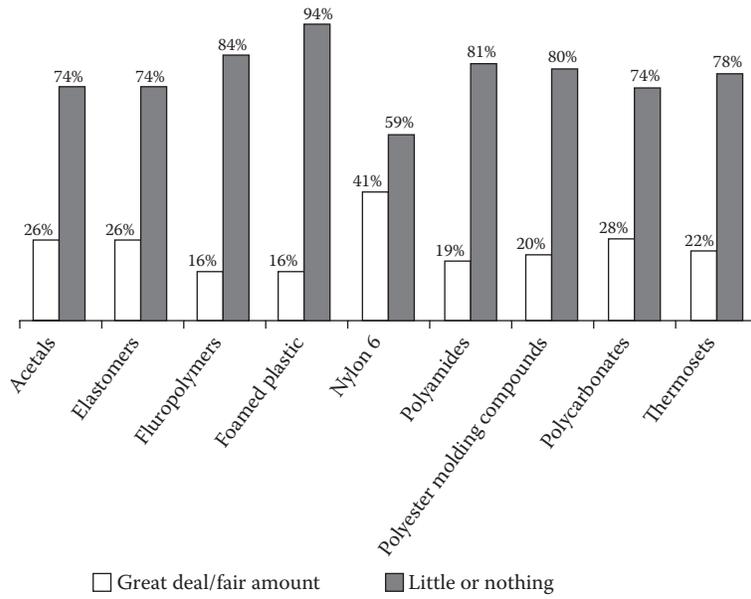


FIGURE 2.3

Compatibility between processes and materials.

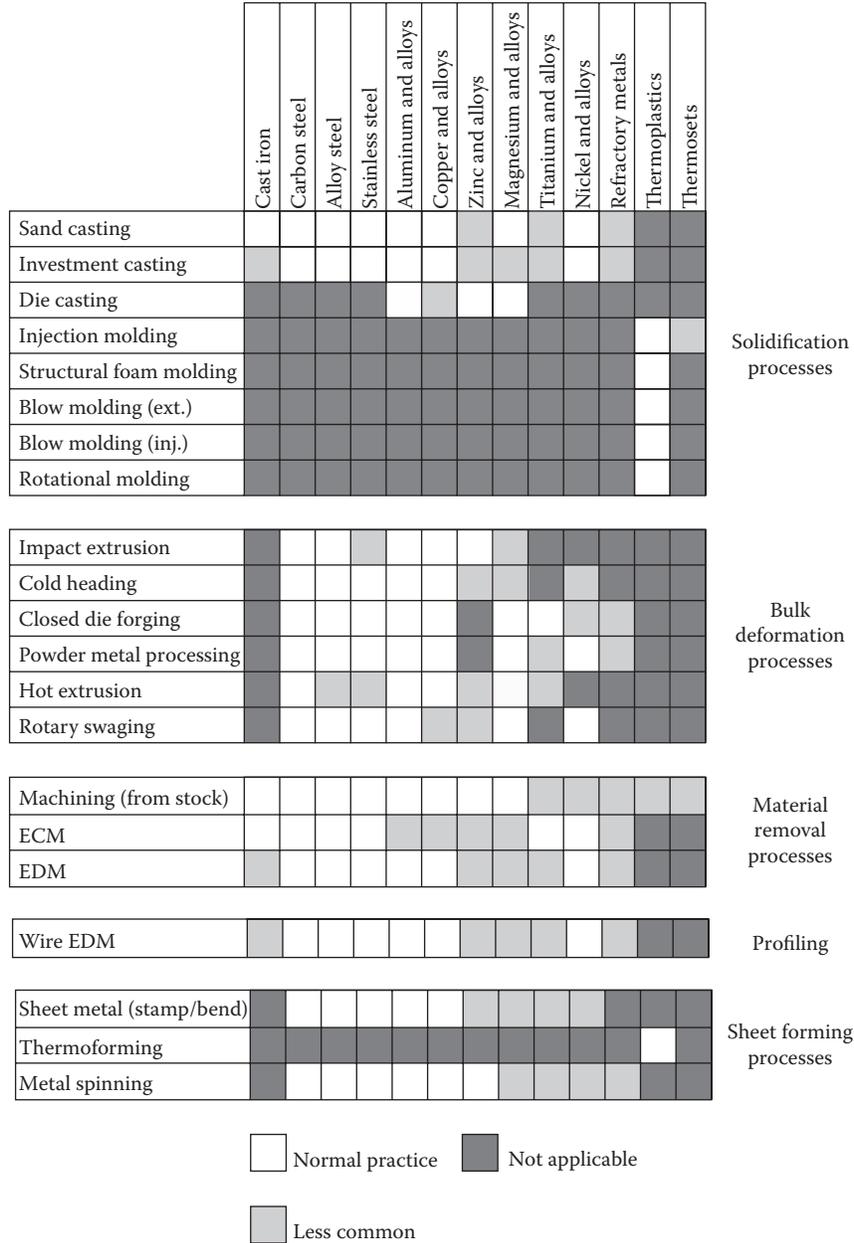


FIGURE 2.4

Membership functions for material and process selection.

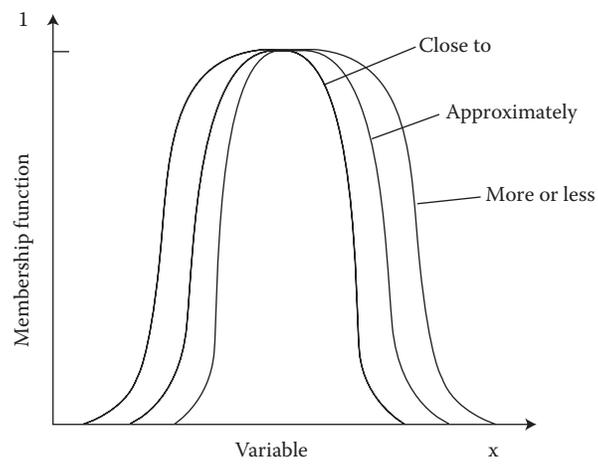


FIGURE 2.5

Selection of sintered powder materials by membership function modification. (Adapted from Farris, J. *Selection of Processing Sequences and Materials During Early Product Design*, Ph.D. Thesis, RI, 1992.)

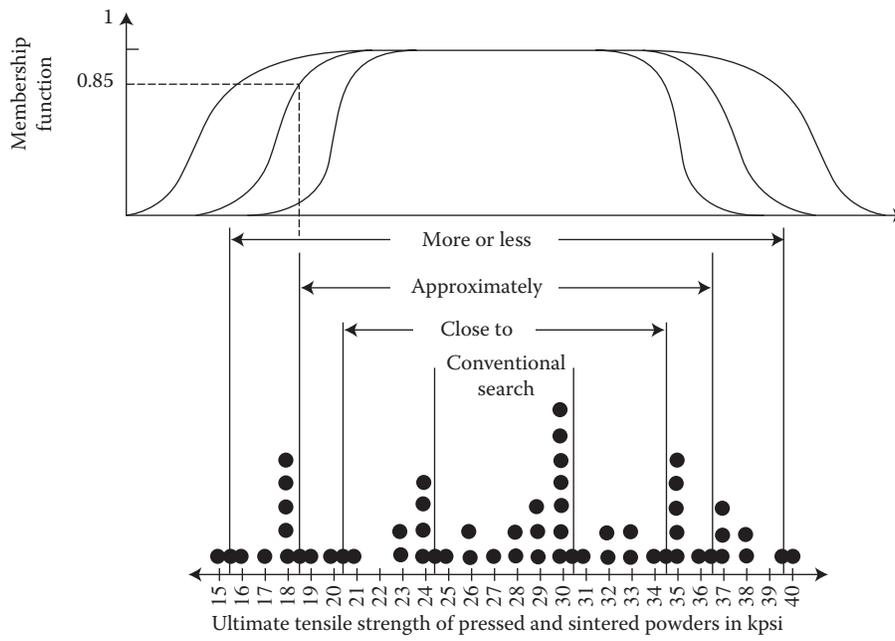


FIGURE 2.6

Elastic modulus for classes of materials plotted on linear scales. (Adapted from Dewhurst, P. and Reynolds, C.R. *Journal of Materials Engineering and Performance*, 6(3), 53–62, 1997.)

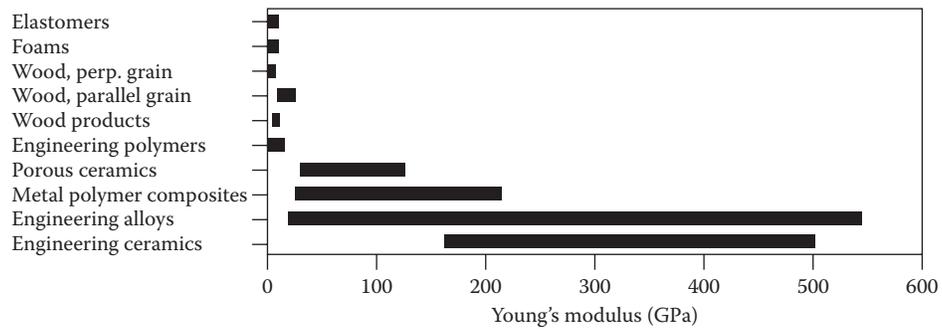


FIGURE 2.7

Elastic modulus for classes of materials plotted on logarithmic scales. (Adapted from Dewhurst, P. and Reynolds, C.R. *Journal of Materials Engineering and Performance*, 6(3), 53–62, 1997.)

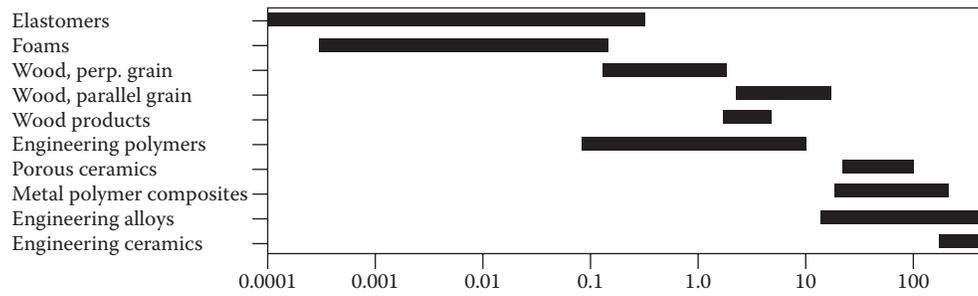
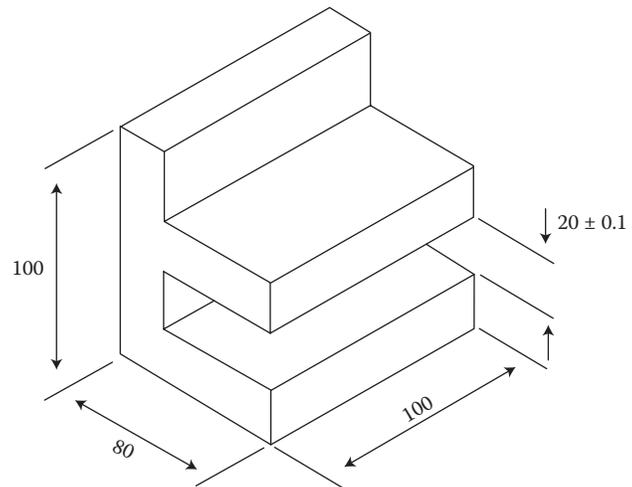


FIGURE 2.8

Oven bracket part.



Dimensions in mm

FIGURE 2.9

Process elimination based on four geometric attributes of the part in Figure 2.8.

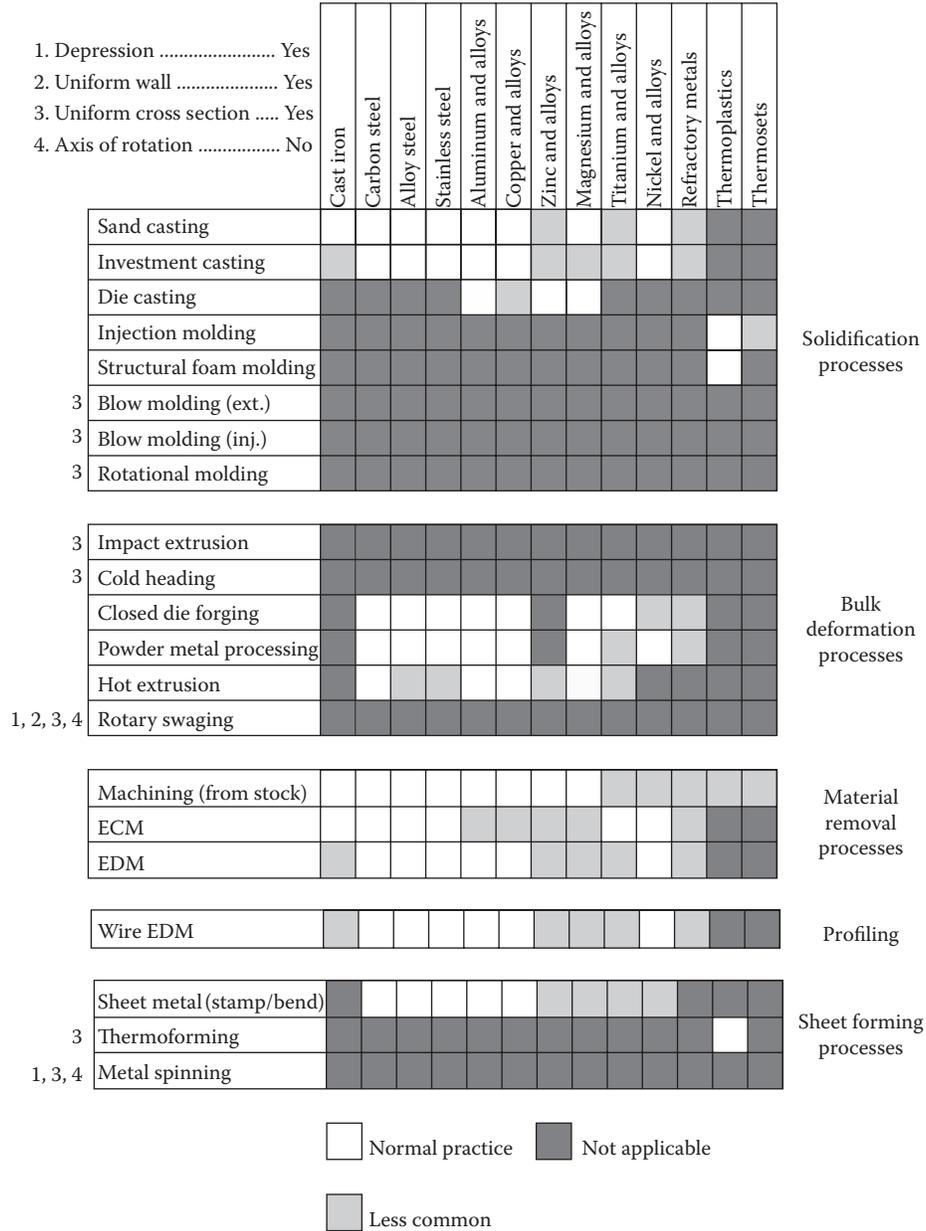


FIGURE 2.10

Process elimination based on further four attributes of the part in Figure 2.8.

		Cast iron	Carbon steel	Alloy steel	Stainless steel	Aluminum and alloys	Copper and alloys	Zinc and alloys	Magnesium and alloys	Titanium and alloys	Nickel and alloys	Refractory metals	Thermoplastics	Thermosets	
5. Regular cross section	No														
6. Captured cavity	No														
7. Enclosed cavity	No														
8. Draft free	Yes														
8	Sand casting														Solidification processes
8	Investment casting														
8	Die casting														
8	Injection molding														
8	Structural foam molding														
6, 8	Blow molding (ext.)														
6, 8	Blow molding (inj.)														
7, 8	Rotational molding														
	Impact extrusion														Bulk deformation processes
	Cold heading														
8	Closed die forging														
	Powder metal processing														
	Hot extrusion														
8	Rotary swaging														
	Machining (from stock)														Material removal processes
8	ECM														
8	EDM														
	Wire EDM														Profiling
8	Sheet metal (stamp/bend)														Sheet forming processes
8	Thermoforming														
8	Metal spinning														

<input type="checkbox"/>	Normal practice	<input type="checkbox"/>	Not applicable
<input type="checkbox"/>	Less common		

FIGURE 2.11

Final process selection based on geometric attributes of the part in Figure 2.8.

All shape attributes	Cast iron	Carbon steel	Alloy steel	Stainless steel	Aluminum and alloys	Copper and alloys	Zinc and alloys	Magnesium and alloys	Titanium and alloys	Nickel and alloys	Refractory metals	Thermoplastics	Thermosets	
Sand casting														Solidification processes
Investment casting														
Die casting														
Injection molding														
Structural foam molding														
Blow molding (ext.)														
Blow molding (inj.)														
Rotational molding														
Impact extrusion														Bulk deformation processes
Cold heading														
Closed die forging														
Powder metal processing														
Hot extrusion														
Rotary swaging														
Machining (from stock)														Material removal processes
ECM														
EDM														
Wire EDM														Profiling
Sheet metal (stamp/bend)														Sheet forming processes
Thermoforming														
Metal spinning														

Normal practice
 Not applicable

Less common

FIGURE 2.12

Final selection based on process/material combinations of the part shown in Figure 2.8.

All shape attributes plus material requirement	Cast iron	Carbon steel	Alloy steel	Stainless steel	Aluminum and alloys	Copper and alloys	Zinc and alloys	Magnesium and alloys	Titanium and alloys	Nickel and alloys	Refractory metals	Thermoplastics	Thermosets	
Sand casting														Solidification processes
Investment casting														
Die casting														
Injection molding														
Structural foam molding														
Blow molding (ext.)														
Blow molding (inj.)														
Rotational molding														
Impact extrusion														Bulk deformation processes
Cold heading														
Closed die forging														
Powder metal processing														
Hot extrusion														
Rotary swaging														
Machining (from stock)														Material removal processes
ECM														
EDM														
Wire EDM														Profiling
Sheet metal (stamp/bend)														Sheet forming processes
Thermoforming														
Metal spinning														

Normal practice

Not applicable

Less common

FIGURE 2.13

General description of proposed part.

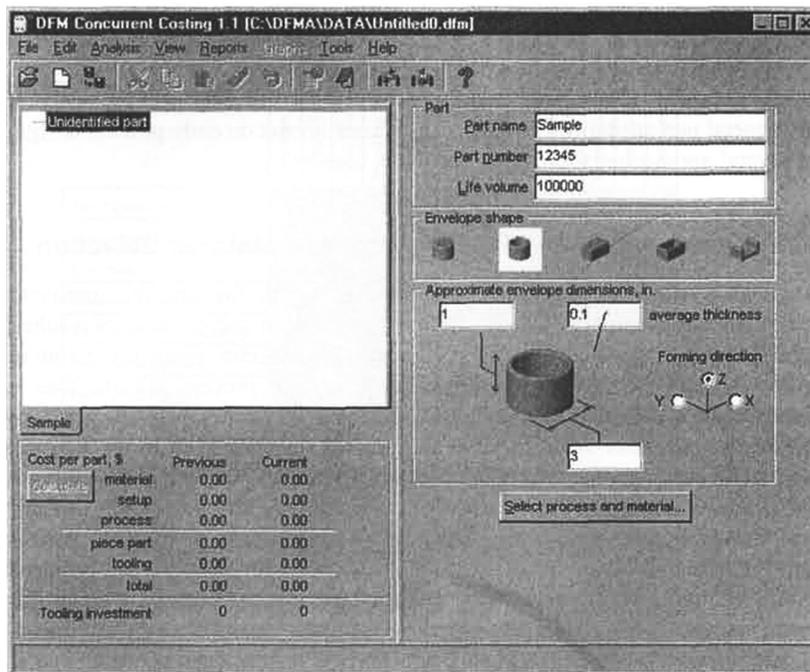


FIGURE 2.14

Material classes compatible with cold-chamber die casting.

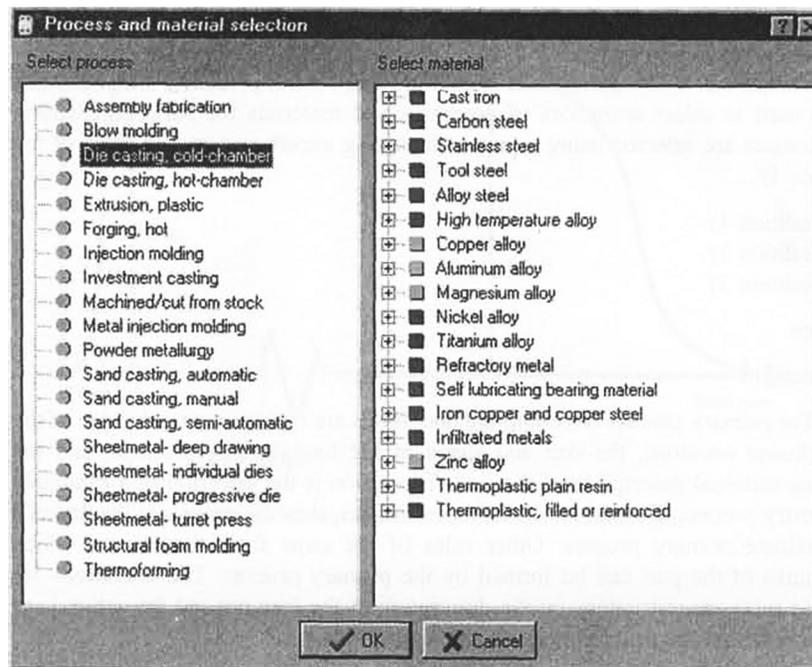


FIGURE 2.15

Example of membership function for process selection rules.

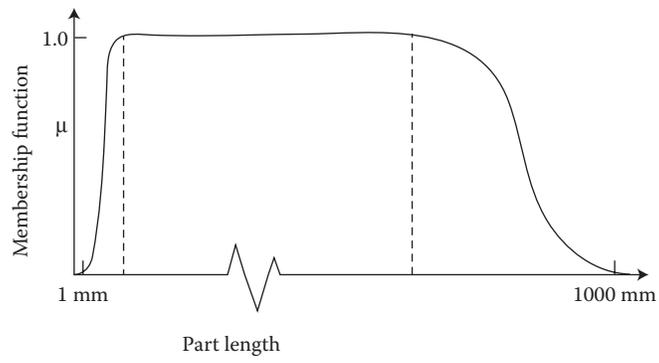


FIGURE 2.16

Procedure for processing sequence selection.

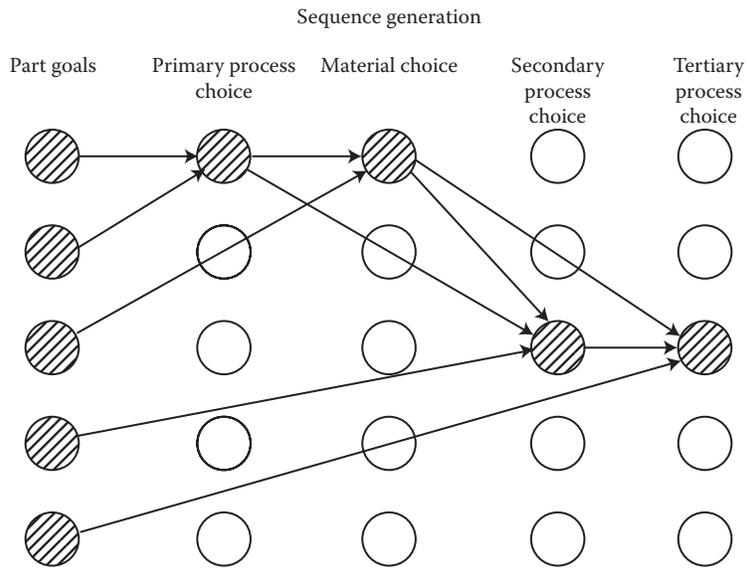
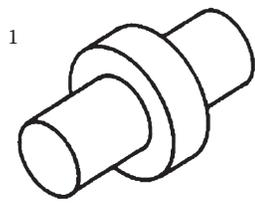
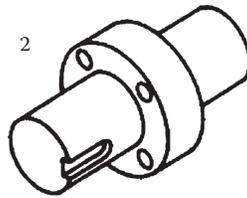


FIGURE 2.17

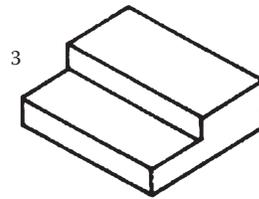
Seven basic categories of machines' component parts. (Adapted from PERA, *Survey of Machining Requirements in Industry*, PERA, Melton Mowbray, UK.)



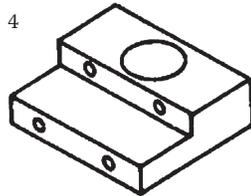
Primary rotational



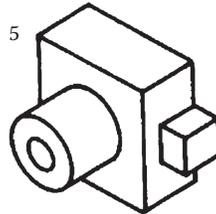
Primary rotational
with secondary



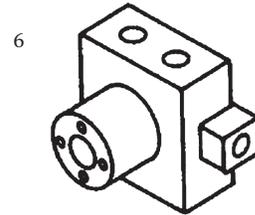
Primary planar



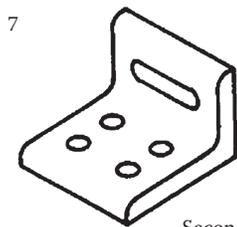
Primary planar
with secondary



Primary planar
and primary rotational



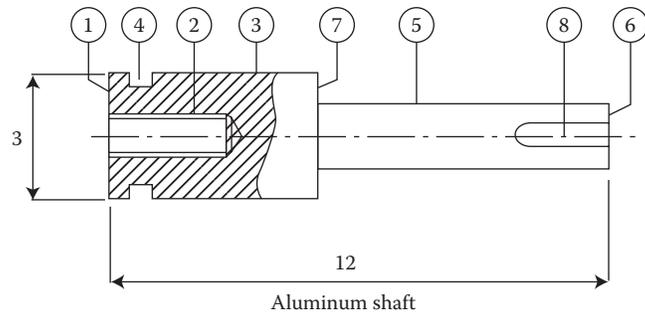
Primary planar
and primary rotational
with secondary



Secondary

FIGURE 2.18

Category 2 part—rotational with secondary features.



Machine	Feature	Operations
Horizontal band saw	–	Cut off workpiece
CNC lathe	1	Finish face
	2	Center drill, drill, tap
	3	Finish tum
	4	Groove
	–	Reclamp
	5	Rough and finish tum
	6	Finish face
Vertical miller	7	Finish face
	8	End mill keyway

FIGURE 2.19

Comparison of machining cost estimates. The cost indicated next to each part drawing is the material cost for the part, ▨, detailed analysis; □, estimate; ▩, initial estimate.

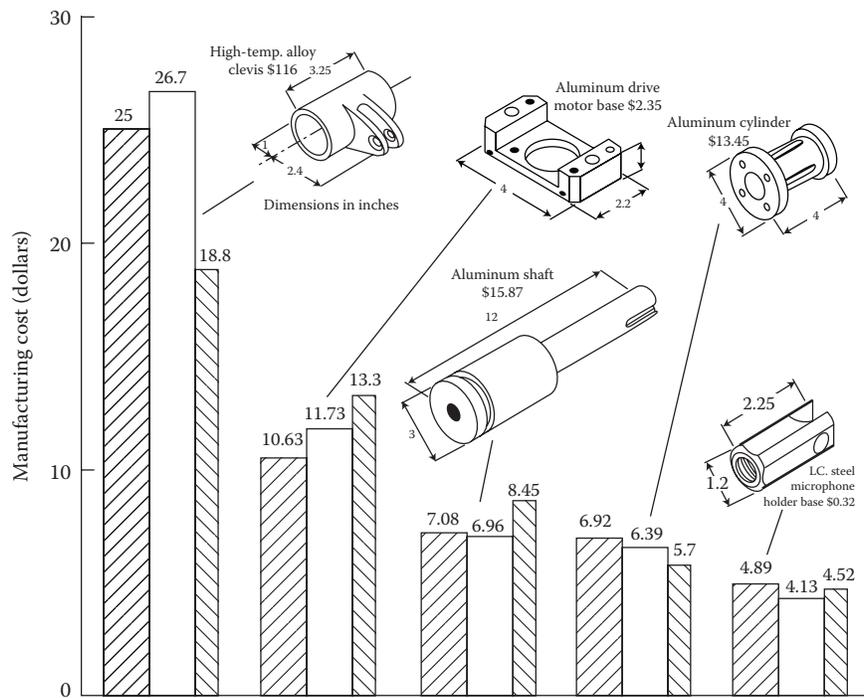


FIGURE 2.20

Connecting rod.

For sand casting, hot forging or powder metal processes these holes will be drilled.
For investment casting, ceramic cores might be used and die casting will require a side pull.

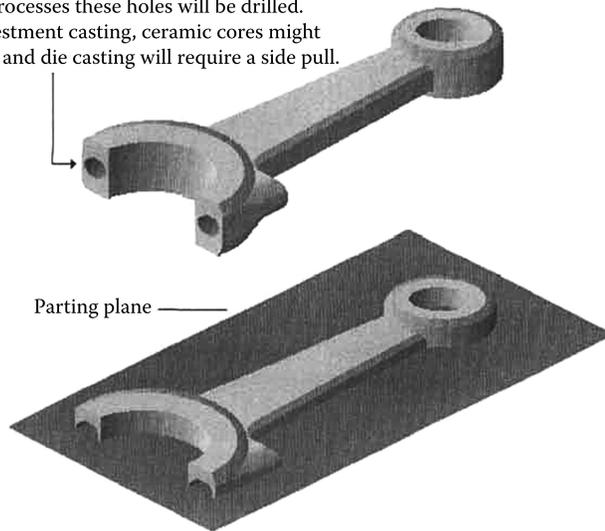


FIGURE 2.21

Connecting rod costs for different processes and production volumes.

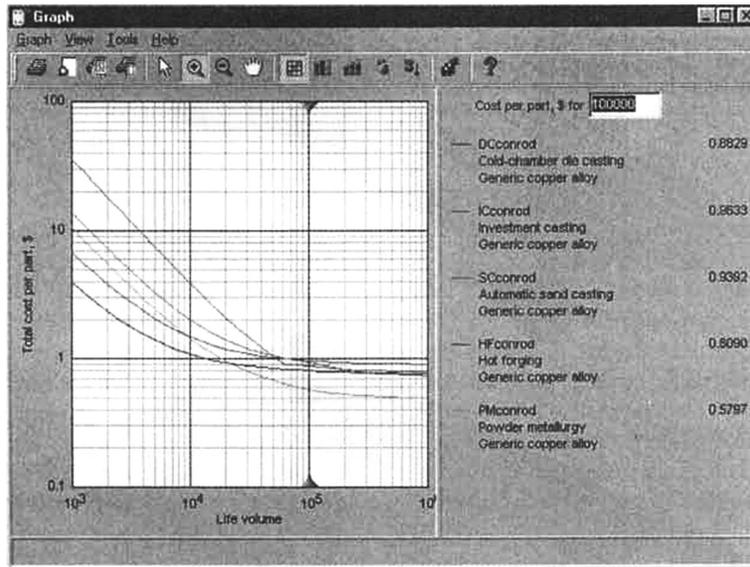


FIGURE 2.22

Cost breakdown for production volume of 100,000.

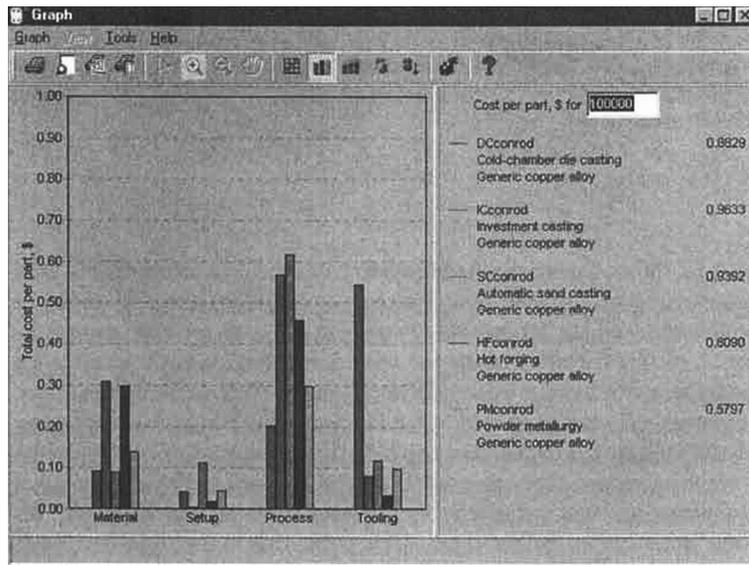


FIGURE 2.23

Cost comparisons for production volume of 100,000.

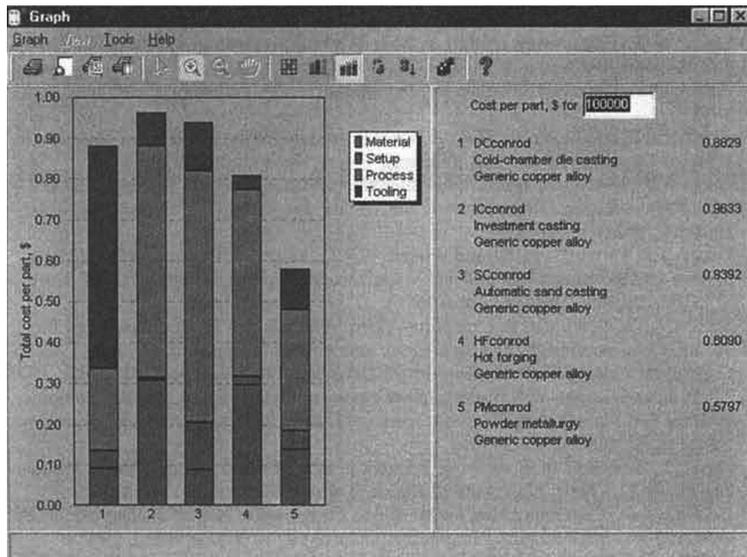


FIGURE 2.24

Hollow metal golf driver head construction.

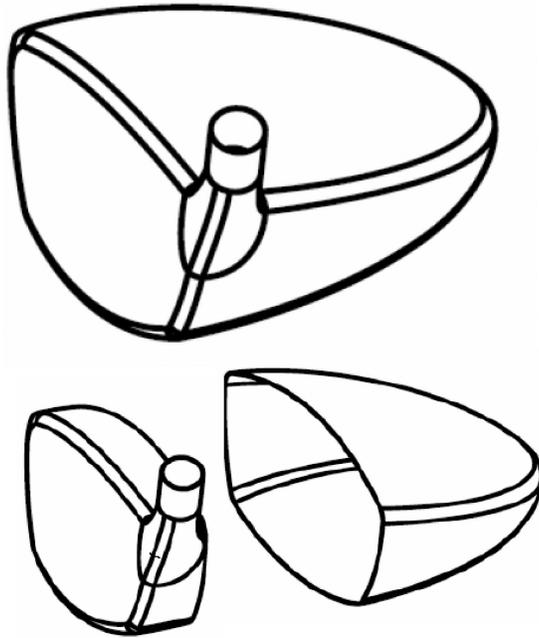


FIGURE 2.25

Electrical instrument support platform.

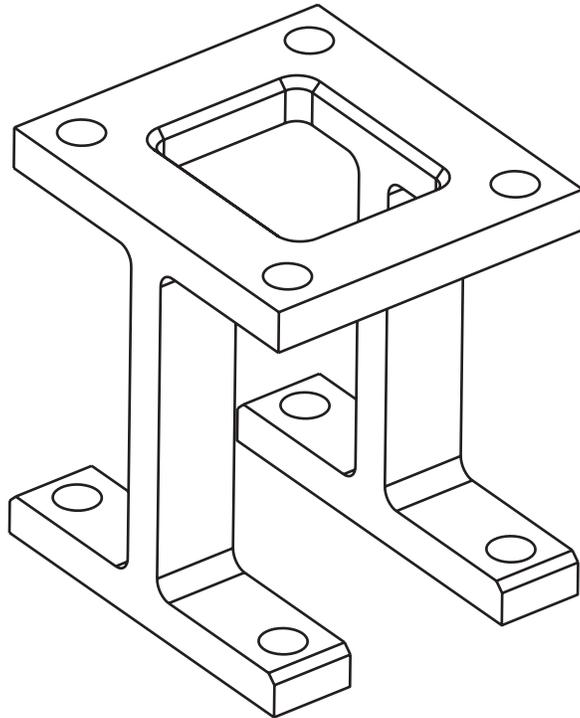


FIGURE 2.26

Rotor housing.

