

BLOQUE I. Tecnologías de fabricación

Tema 0. Introducción a los procesos de tecnologías de fabricación

Introducción a las Tecnologías de Fabricación

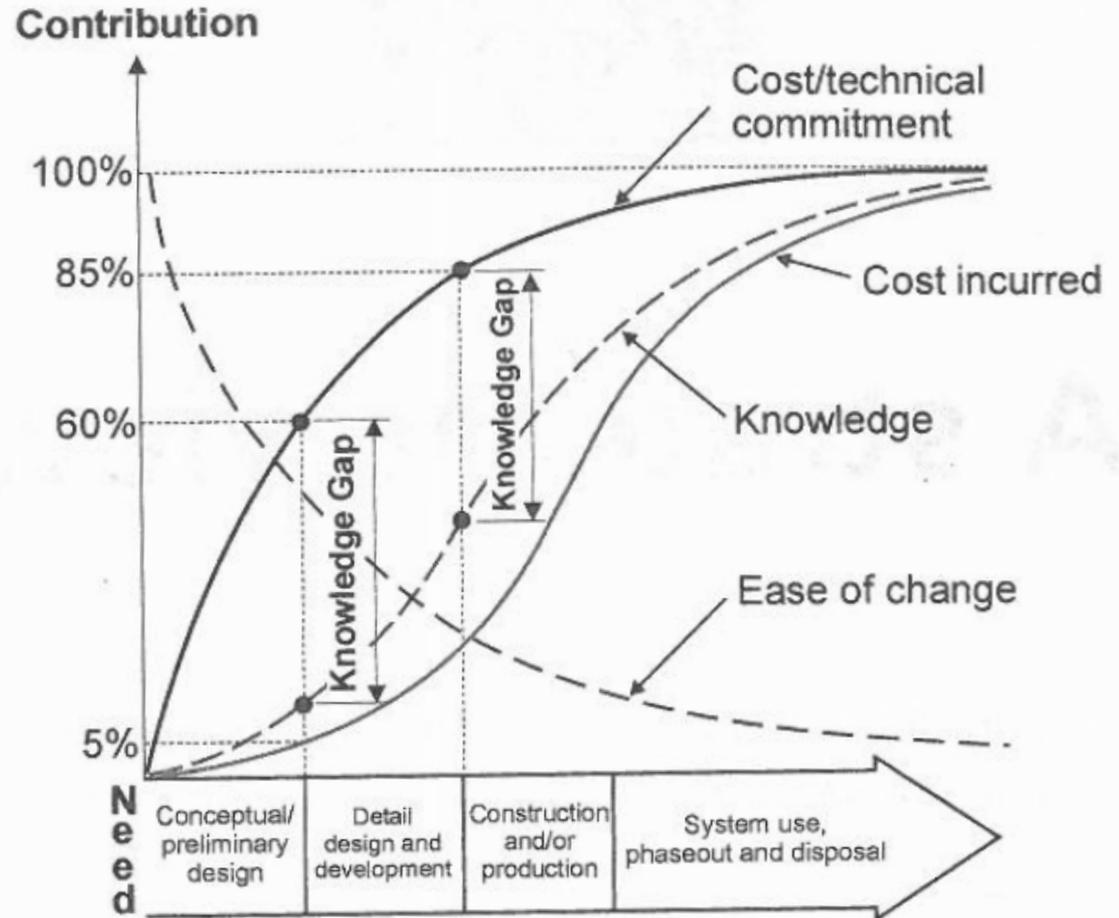
Las tecnologías de fabricación son un pilar básico de la producción industrial



Introducción a las Tecnologías de Fabricación

Selección del proceso de fabricación

El diseño de un correcto proceso de fabricación es fundamental → Dificultad para cambiar durante la realización del proceso



Introducción a las Tecnologías de Fabricación

Reducción de costes

SELECCIÓN DE
MATERIALES

OPTIMIZACIÓN DEL
DISEÑO

Coste del
material

Cantidad, tipo → Además tiene influencia sobre el proceso que se puede aplicar

Coste del proceso
de fabricación

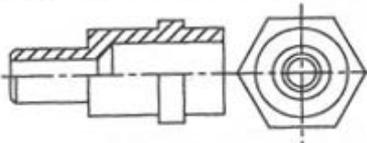
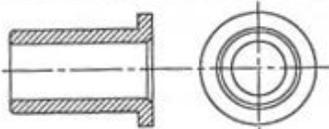
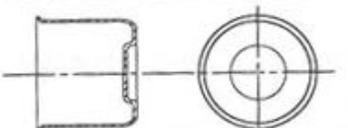
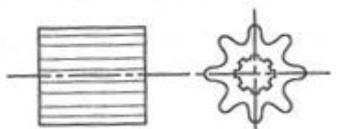
Análisis de las alternativas según el material, la geometría, número de unidades → Tener en cuenta aspectos como el número de operaciones secundarias requeridas

Costes de
ensamblaje

Reducción del número de operaciones de ensamblaje
→ Reducción del número de piezas a ensamblar

Introducción a las Tecnologías de Fabricación

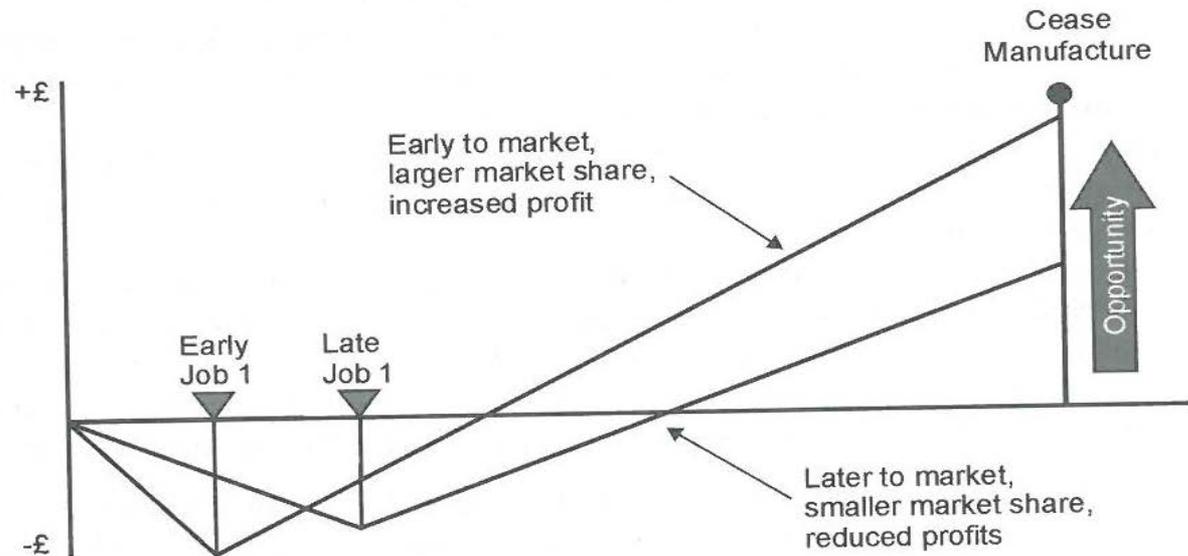
Reducción de costes - Ejemplos

Component	Material	Number Per Annum	Manufacturing Process	Relative Economic and Technical Merits	Relative Cost
 Plug Body	Low Carbon Steel	1,000,000	Machining	High waste Low to medium production rates Poor strength	3.9
			Cold Forming	Little waste Very high production rates High strength	1
 Plain Bearing	Bronze	50,000	Machining	High waste Low to medium production rates Non-porous properties	2.2
			Powder Metal Sintering	No waste High production rates Porous product	1
 Cover	Alum. Alloy	5,000	Spinning	High labour costs Low production rates Limited detail and accuracy	1.8
			Deep Drawing	Low labour costs High production rates High detail and accuracy	1
 Connecting Rod (after (1.6))	Medium Carbon Steel	100,000	Closed Die Forging	Long lead times High tooling costs High equipment costs	1.3
			Sand Casting	Short lead times Low tooling costs Low equipment costs	1
 Pump Gear	Low Carbon Steel	5,000	Machining	High waste Low to medium production rates Poor strength	2.6
			Cold Extrusion	Little waste Very high production rates High strength	1

Introducción a las Tecnologías de Fabricación

Aspectos generales durante la etapa de diseño

La implantación de técnicas o estrategias de diseño conlleva esfuerzos mayores durante esta etapa, sin embargo, pueden reducir el tiempo final de lanzamiento de un producto



Mayor coste inicial de diseño

Mayor facilidad de ensamblaje y fabricación

Menor complejidad del producto final

Menor número de piezas

Menor número de cambios (rediseño)

Introducción a las Tecnologías de Fabricación

Aspectos generales durante la etapa de diseño

DFA (Design for Assembly)

Simplificación de la estructura del producto, reducción del número de componentes/piezas → Reducción de operaciones de ensamblaje, problemas asociados a las mismas

DFM (Design for manufacturing)

Modificaciones en el diseño del producto para lograr una mayor facilidad en la fabricación → Elevado conocimiento de los procesos de fabricación, limitaciones y recomendaciones sobre los mismos

DFE (Design for environment)

Los productos deben diseñarse teniendo en cuenta el efecto causado sobre el medio ambiente, desde su fabricación inicial hasta su desechado → *Análisis del ciclo de vida* → From Cradle to Grave

Introducción a las Tecnologías de Fabricación

Aspectos generales durante la etapa de diseño

DFA (Design for Assembly)

Overall Results

- 70% fewer parts
- 15% reduction in total cost
- 35% shorter build time
- Simpler Manufacturing system
- Improved reliability and performance



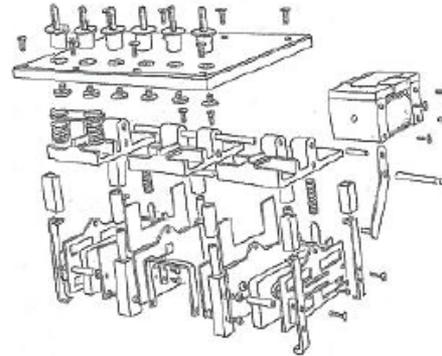
Original Design

- 60 off
- 14 parts
- Mild steel
- Fabricated (welded)
- Normalised
- No machining (as supplied)
- £295 per unit

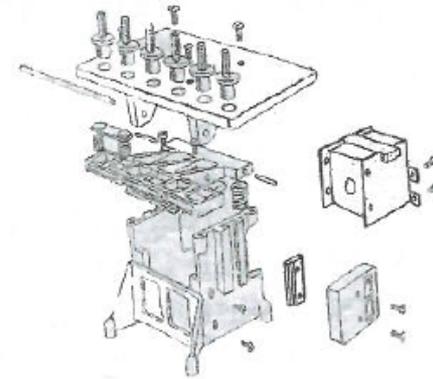
Redesign

- Single piece casting
- Manufacturing estimate £30 per unit
- Quote £29 per unit
- Pattern £500
- Total cost £36 per unit

Original Design 402 Parts



Redesign 137 Parts



Business Sector	Automotive	Aerospace/ Defence	Industrial Equipment	All Sectors
Average Part-count Reduction	44%	52%	51%	48%
Average Assembly Cost Saving	43%	47%	48%	45%

Introducción a las Tecnologías de Fabricación

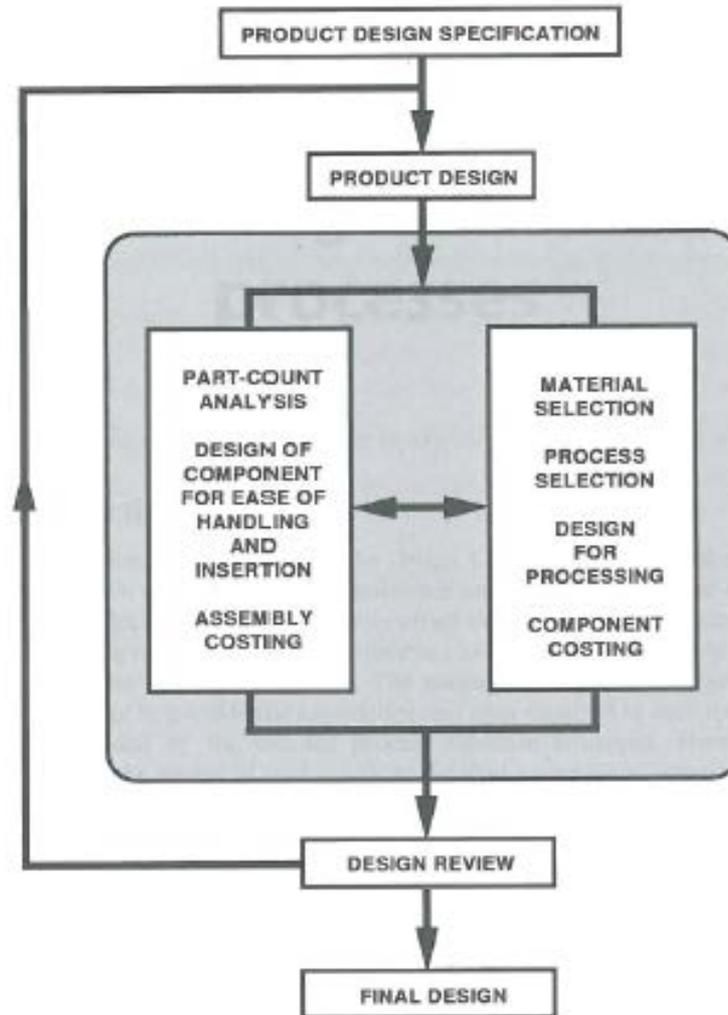
Aspectos generales durante la etapa de diseño

DFM (Design for manufacturing) → Recomendaciones generales

- Identificación de características críticas (tolerancias, acabados superficiales)
- Establecer tolerancias máximas para cada característica relevante del diseño
- Determinar capacidad de los procesos para dichas características
- Evitar tolerancias muy ajustadas
- Tener en cuenta tareas de inspección de las piezas
- Minimizar el número de superficies a mecanizar
- Emplear métodos comunes de fabricación, si es posible
- Diseñar radios y perfiles con holgura en colada, moldeo o mecanizado
- Evitar operaciones secundarias, tanto como sea posible
- Empleo de un buen diseño detallado según norma donde queden claros todos los aspectos del proceso de fabricación (útiles, insertos, etc.)

Introducción a las Tecnologías de Fabricación

Aspectos generales durante la etapa de diseño



Introducción a las Tecnologías de Fabricación

Selección del proceso de fabricación

Algunos de los criterios más habituales para seleccionar un proceso de fabricación:

Requerimientos previos

Número de unidades

Mano de obra

Coste de los equipos

Disponibilidad y coste del material

Número de unidades

Calidad superficial

Coste de herramientas (moldes, etc.)

Pérdida de material

Mantenimiento

Geometría

Reciclabilidad

Tolerancias

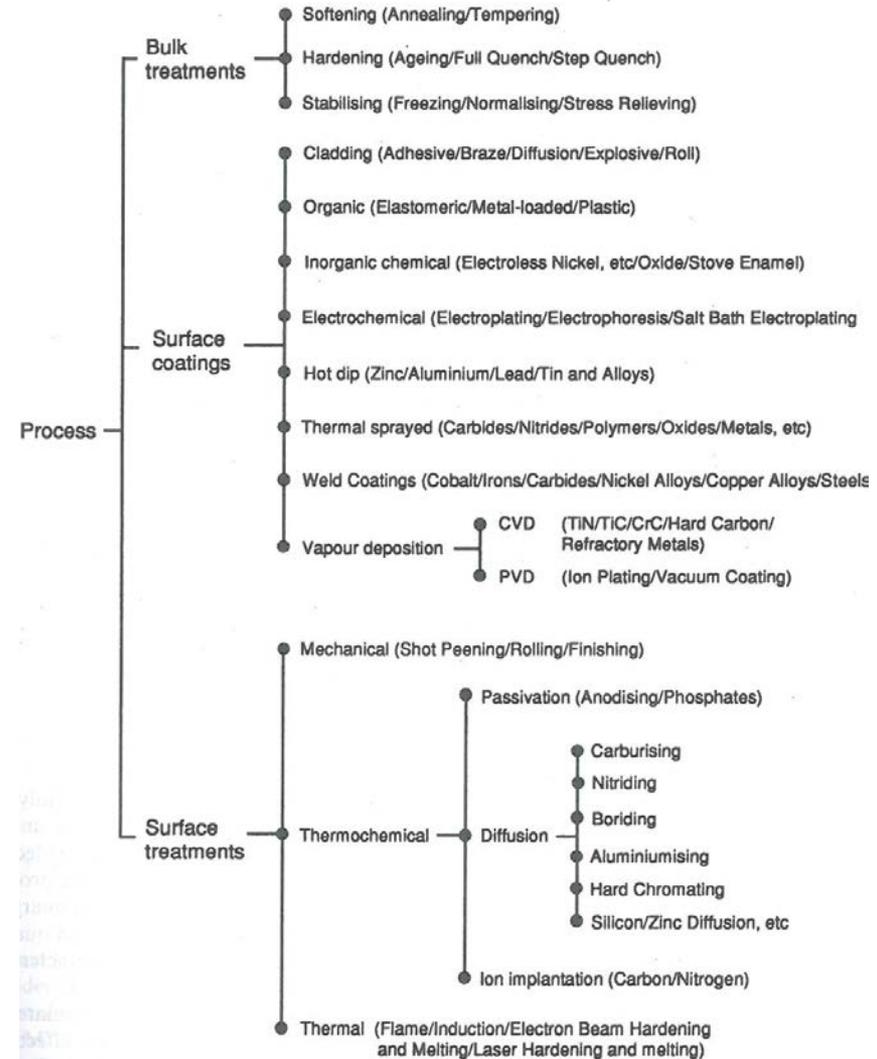
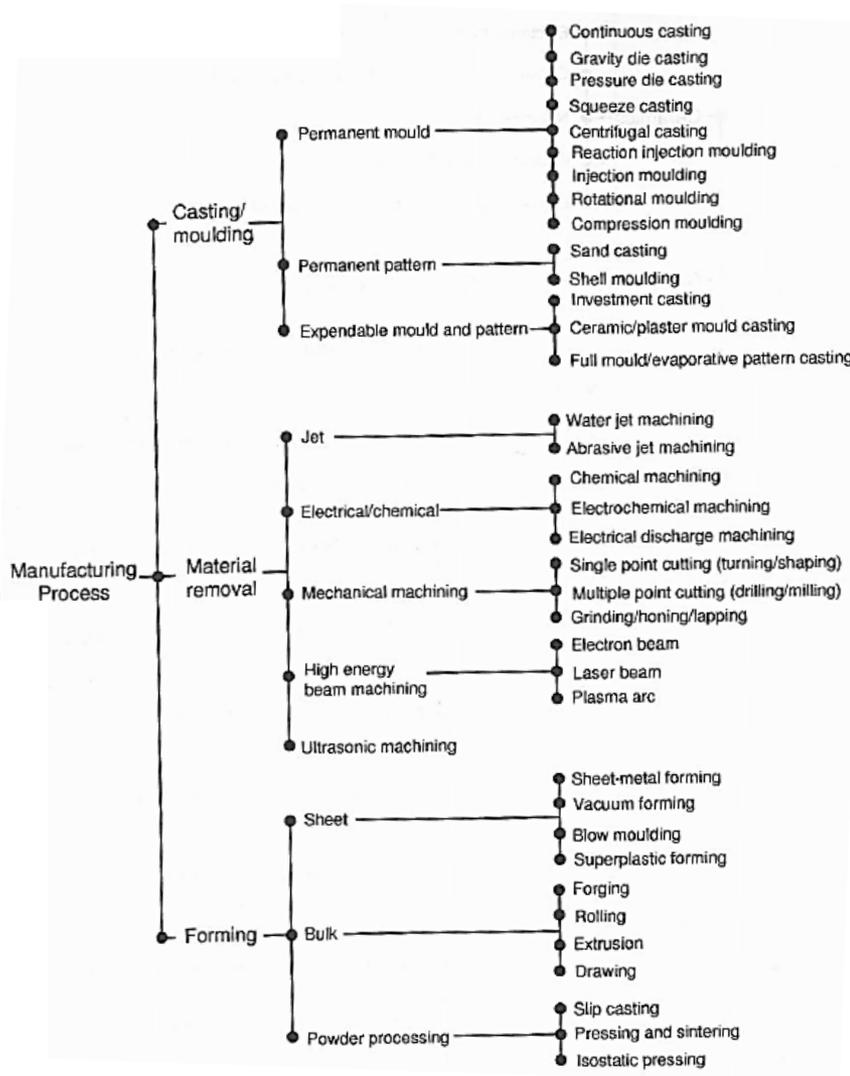
Tiempo de procesado

Consumo energético

Introducción a las Tecnologías de Fabricación

Tecnologías de fabricación

Existen un gran número de técnicas de fabricación



Introducción a las Tecnologías de Fabricación

Tecnologías de fabricación

No todas son posibles con todos los tipos de materiales y geometrías

Tablas, mapas, programas de selección

MATERIAL QUANTITY	IRONS	STEEL (carbon)	STEEL (tool, alloy)	STAINLESS STEEL	COPPER & ALLOYS	ALUMINIUM & ALLOYS	MAGNESIUM & ALLOYS	ZINC & ALLOYS	TIN & ALLOYS	LEAD & ALLOYS	NICKEL & ALLOYS	TITANIUM & ALLOYS	THERMOPLASTICS	THERMOSETS	FR COMPOSITES	CERAMICS	REFRACTORY METALS	PRECIOUS METALS
	VERY LOW 1 TO 100	[1.5][1.6] [1.7][4.M]	[1.5][1.7] [3.10][4.M] [5.1][5.5] [5.6]	[1.1][1.5][1.7] [3.10][4.M]	[1.5][1.7][3.7] [3.10][4.M] [5.1][5.5][5.6]	[1.5][1.7] [3.10][4.M] [5.1]	[1.5][1.7] [3.7][3.10] [4.M][5.6]	[1.6][1.7] [3.10][4.M] [5.1][5.5]	[1.1][1.7] [3.10][4.M] [5.5]	[1.1][1.7] [3.10][4.M] [5.5]	[1.1][3.10] [4.M][5.5]	[1.5][1.7] [3.10][4.M] [5.1][5.5][5.6]	[1.1][1.6] [3.7][3.10] [4.M][5.1] [5.5][5.6][5.7]	[2.5] [3.7]	[2.5] [5.7]	[2.2] [2.6] [5.7]	[1.5] [2.1] [2.5] [5.7]	[1.1] [5.7]
LOW 100 TO 1,000	[1.2][1.5] [1.6][1.7] [4.M] [5.3][5.4]	[1.2][1.5] [1.7][3.10] [4.M][5.1] [5.3][5.4]	[1.1][1.2][1.7] [4.M][5.1] [5.3][5.4]	[1.2][1.7] [3.7][3.10] [4.M][5.1] [5.3][5.4]	[1.2][1.6] [1.7][1.8][3.5] [4.M][5.1] [5.3][5.4]	[1.2][1.5][1.7] [1.8][3.7][3.10] [4.M][5.3] [5.4][5.6]	[1.6][1.7] [1.8][3.10] [4.M][5.5]	[1.1][1.7] [3.10][4.M] [5.5]	[1.1][1.7] [3.10][4.M] [5.5]	[1.1][1.8] [3.10][4.M] [5.5]	[1.2][1.5][1.7] [3.10][4.M] [5.1][5.3] [5.4][5.6]	[1.1][1.6][3.7] [3.10][4.M][5.1] [5.3][5.4][5.6]	[2.3] [2.7]	[2.3] [2.7]	[2.2] [2.6] [5.7]	[1.5] [2.1] [2.5] [5.7]	[1.1] [5.7]	[5.5]
LOW TO MEDIUM 1,000 TO 10,000	[1.2][1.3] [1.6][1.7] [1.7][3.11] [4.A][5.2]	[1.2][1.3][1.5] [1.7][3.10] [3.10][3.11] [4.A][5.2][5.3] [5.4]	[1.2][1.5][1.7] [3.10][4.M] [4.A][5.2][5.3] [5.4]	[1.2][1.5][1.7] [3.10][4.M] [4.A][5.2][5.3] [5.4]	[1.2][1.3][1.5] [1.6][3.10] [3.10][3.11][4.A] [5.2][5.3][5.4]	[1.2][1.3][1.5] [1.6][3.10] [3.7][3.10][3.11] [4.A][5.2][5.3][5.4]	[1.3][1.6] [1.8][3.10] [3.7][3.10] [4.A][5.5]	[1.3][1.6] [3.2][3.10] [4.A][5.5]	[1.3][1.8] [3.2][3.10] [4.A][5.5]	[1.3][1.8] [3.2][3.10]	[1.3][1.8] [3.2][3.10]	[1.2][1.3][1.5] [1.7][3.10] [3.10][4.A][5.2] [5.3][5.4][5.5] [5.6]	[3.1] [3.7]	[2.3] [2.7]	[2.2] [2.6] [5.7]	[1.5] [2.1] [2.5] [5.7]	[1.1] [5.7]	[5.5]
MEDIUM TO HIGH 10,000 TO 100,000	[1.2][1.3] [3.11][4.A]	[1.2][1.3] [3.10][3.11] [4.A][5.2][5.3] [5.4]	[1.2][1.3][1.5] [3.10][4.M] [4.A][5.2]	[1.2][1.3] [3.10][3.11] [3.12][4.A]	[1.2][1.3][1.5] [3.10][3.11] [3.12][4.A]	[1.2][1.3][1.4] [1.6][3.10] [3.4][3.11] [3.12][4.A]	[1.3][1.4] [3.10][3.11] [3.12][4.A]	[1.3][1.4] [3.10][3.11] [3.12][4.A]	[1.3][1.4] [3.10][3.11] [3.12][4.A]	[1.3][1.4] [3.10][3.11] [3.12][4.A]	[1.3][1.4] [3.10][3.11] [3.12][4.A]	[1.2][1.3][1.5] [1.7][3.10] [3.10][4.A][5.2] [5.3][5.4][5.5] [5.6]	[2.1] [2.3] [2.6] [2.7]	[2.1] [2.3] [2.6] [2.7]	[2.1] [2.3] [2.6] [2.7]	[1.5] [2.1] [2.5] [5.7]	[1.1] [5.7]	[5.5]
HIGH 100,000+	[1.2][1.3] [3.11] [4.A]	[1.2][1.3] [3.10][3.11] [3.12][4.A]	[4.A]	[1.2][1.3] [3.10][4.A]	[1.2][1.3][1.4] [1.6][3.10] [3.4][3.11] [3.12][4.A]	[1.2][1.3][1.4] [1.6][3.10] [3.4][3.11] [3.12][4.A]	[1.3][1.4] [3.10][3.11] [3.12][4.A]	[1.3][1.4] [3.10][3.11] [3.12][4.A]	[1.3][1.4] [3.10][3.11] [3.12][4.A]	[1.3][1.4] [3.10][3.11] [3.12][4.A]	[1.3][1.4] [3.10][3.11] [3.12][4.A]	[1.2][1.3][1.5] [1.7][3.10] [3.10][4.A][5.2] [5.3][5.4][5.5] [5.6]	[2.1] [2.3] [2.6] [2.7]	[2.1] [2.3] [2.6] [2.7]	[2.1] [2.3] [2.6] [2.7]	[1.5] [2.1] [2.5] [5.7]	[1.1] [5.7]	[5.5]
ALL QUANTITIES	[1.1]	[1.1][1.6] [3.6][3.8] [3.9]	[1.6][3.6]	[1.1][1.6] [3.6][3.8] [3.9]	[1.1][1.6] [3.6][3.8] [3.9]	[1.1][1.6] [3.6][3.8] [3.9]	[1.1][3.6] [3.6][3.8] [3.9]	[3.6][3.8] [3.9]	[1.1][1.6] [3.6][3.8] [3.9]	[3.6]	[1.1][1.6] [3.6][3.8] [3.9]	[3.6][3.8] [3.9]				[5.5]	[1.6]	[1.6]

KEY TO MANUFACTURING PROCESS PRIMA SELECTION MATRIX:

CASTING PROCESSES

- [1.1] SAND CASTING
- [1.2] SHELL MOLDING
- [1.3] GRAVITY DIE CASTING
- [1.4] PRESSURE DIE CASTING
- [1.5] CENTRIFUGAL CASTING
- [1.6] INVESTMENT CASTING
- [1.7] CERAMIC MOLD CASTING
- [1.8] PLASTER MOLD CASTING
- [1.9] SQUEEZE CASTING

PLASTIC & COMPOSITE PROCESSING

- [2.1] INJECTION MOLDING
- [2.2] REACTION INJECTION MOLDING
- [2.3] COMPRESSION MOULDING
- [2.4] TRANSFER MOLDING
- [2.5] VACUUM FORMING
- [2.6] BLOW MOLDING
- [2.7] ROTATIONAL MOLDING
- [2.8] CONTACT MOLDING
- [2.9] CONTINUOUS EXTRUSION (PLASTICS)

FORMING PROCESSES

- [3.1] CLOSED DIE FORGING
- [3.2] ROLLING
- [3.3] DRAWING
- [3.4] COLD FORMING
- [3.5] COLD HEADING
- [3.6] SWAGING
- [3.7] SUPERPLASTIC FORMING
- [3.8] SHEET-METAL SHEARING
- [3.9] SHEET-METAL FORMING
- [3.10] SPINNING
- [3.11] POWDER METALLURGY
- [3.12] CONTINUOUS EXTRUSION (METALS)

MACHINING PROCESSES

- [4.A] AUTOMATIC MACHINING
 - [4.M] MANUAL MACHINING
- (THE ABOVE HEADINGS COVER A BROAD RANGE OF MACHINING PROCESSES AND LEVELS OF CONTROL TECHNOLOGY. FOR MORE DETAIL, THE READER IS REFERRED TO THE INDIVIDUAL PROCESSES.)

NTM PROCESSES

- [5.1] ELECTRICAL DISCHARGE MACHINING (EDM)
- [5.2] ELECTROCHEMICAL MACHINING (ECM)
- [5.3] ELECTRON BEAM MACHINING (EBM)
- [5.4] LASER BEAM MACHINING (LBM)
- [5.5] CHEMICAL MACHINING (CM)
- [5.6] ULTRASONIC MACHINING (USM)
- [5.7] ABRASIVE JET MACHINING (AJM)