5.6 Cast Irons
Case Study Fish Hooks

Chapter 6 Heat Treatment
6.1 Introduction
6.2 Processing Heat Treatments
6.3 Heat Treatments Used to Increase Strength
6.4 Strengthening Heat Treatments for Nonferrous Metals
6.5 Strengthening Heat Treatments for Steel
6.6 Surface Hardening of Steel
6.7 Furnaces
6.8 Heat Treatment and Energy
Case Study A Carpenter's Claw Hammer

Chapter 7 Ferrous Metals and Alloys
7.1 Introduction to History-Dependent Materials
7.2 Ferrous Metals
7.3 Iron
7.4 Steel
7.5 Stainless Steels
7.6 Tool Steels
7.7 Cast Irons
7.8 Cast Steels
7.9 The Role of Processing on Cast Properties
Case Study The Paper Clip

Chapter 8 Nonferrous Metals and Alloys
8.1 Introduction
8.2 Copper and Copper Alloys
8.3 Aluminum and Aluminum Alloys
8.4 Magnesium and Magnesium Alloys
8.5 Zinc and Zinc Alloys
8.6 Titanium and Titanium Alloys
8.7 Nickel-Based Alloys
8.8 Superalloys, Refractory Metals, and Other Materials Designed for High-Temperature Service
8.9 Lead and Tin, and Their Alloys
8.10 Some Lesser-Known Metals and Alloys
8.11 Metallic Glasses
8.12 Graphite
Case Study Hip Replacement Prosthetics

(In old ed it is chapter 8) Chapter 9 Nonmetallic Materials: Plastics, Elastomers, Ceramics, and Composites
9.1 Introduction
9.2 Plastics
9.3 Elastomers
9.4 Ceramics
9.5 Composite Materials
Case Study Lightweight Armor (changed)
Chapter 10 Material Selection
10.1 Introduction
10.2 Material Selection and Manufacturing Processes
10.3 The Design Process
10.4 Approaches to Material Selection
10.5 Additional Factors to Consider
10.6 Consideration of the Manufacturing Process
10.7 Ultimate Objective
10.8 Materials Substitution
10.9 Effect of Product Liability on Materials Selection
10.10 Aids to Material Selection
Case Study Material Selection

(Same chapter in old ed) Chapter 11 Fundamentals of Casting
11.1 Introduction to Materials Processing
11.2 Introduction to Casting
11.3 Casting Terminology
11.4 The Solidification Process
11.5 Patterns
11.6 Design Considerations in Castings
11.7 The Casting Industry
Case Study The Cast Oil-Field Fitting

(Same chapter in old ed) Chapter 12 Expendable-Mold Casting Processes
12.1 Introduction
12.2 Sand Casting
12.3 Cores and Core Making
12.4 Other Expendable-Mold Processes with Multiple-Use Patterns
12.5 Expendable-Mold Processes Using Single-Use Patterns
12.6 Shakeout, Cleaning, and Finishing
12.7 Summary
Case Study Movable and Fixed Jaw Pieces for a Heavy-Duty Bench Vise

(Same chapter in old ed) Chapter 13 Multiple-Use-Mold Casting Processes
13.1 Introduction
13.2 Permanent-Mold Casting
13.3 Die Casting
13.4 Squeeze Casting and Semisolid Casting
13.5 Centrifugal Casting
13.6 Continuous Casting
13.7 Melting
13.8 Pouring Practice
13.9 Cleaning, Finishing, and Heat Treating of Castings
13.10 Automation in Foundry Operations
13.11 Process Selection
Case Study Baseplate for a Household Steam Iron

Chapter 14 Fabrication of Plastics, Ceramics, and Composites
14.1 Introduction
14.2 Fabrication of Plastics
14.3 Processing of Rubber and Elastomers
14.4 Processing of Ceramics
14.5 Fabrication of Composite Materials
Case Study Automotive and Light Truck Fuel Tanks

( Same chapter in old ed ) Chapter 15 Fundamentals of Metal Forming
15.1 Introduction
15.2 Forming Processes: Independent Variables
15.3 Dependent Variables
15.4 Independent-Dependent Relationships
15.5 Process Modeling
15.6 General Parameters
15.7 Friction and Lubrication Under Metalworking Conditions
15.8 Temperature Concerns
15.9 Formability ( New Section)
Case Study Interior Tub of a Top-Loading Washing Machine ( New Case)

( Same chapter in old ed ) Chapter 16 Bulk-Forming Processes
16.1 Introduction
16.2 Classification of Deformation Processes
16.3 Bulk Deformation Processes
16.4 Rolling
16.5 Forging
16.6 Extrusion
16.7 Wire, Rod, and Tube Drawing
16.8 Cold Forming, Cold Forging, and Impact Extrusion
16.9 Piercing
16.10 Other Squeezing Processes
16.11 Surface Improvement by Deformation Processing
Case Study Handle and Body of a Large Ratchet Wrench

( Same chapter in old ed ) Chapter 17 Sheet-Forming Processes
17.1 Introduction
17.2 Shearing Operations
17.3 Bending
17.4 Drawing and Stretching Processes
17.5 Alternative Methods of Producing Sheet-Type Products
17.6 Pipe Manufacture
17.7 Presses
Case Study Automotive Body Panels (New Case)

Chapter 18 Powder Metallurgy
18.1 Introduction
18.2 The Basic Process
18.3 Powder Manufacture
18.4 Microcrystalline and Amorphous Material Produced by Rapid Cooling
18.5 Powder Testing and Evaluation
18.6 Powder Mixing and Blending
18.7 Compacting
18.8 Sintering
18.9 Recent Advances in Sintering
18.10 Hot-Isostatic Pressing
18.11 Other Techniques to Produce High-Density Powder Metallurgy Products
18.12 Metal Injection Molding or Powder Injection Molding
18.13 Secondary Operations
18.14 Properties of Powder Metallurgy Products
18.15 Design of Powder Metallurgy Parts
18.16 Powder Metallurgy Products
18.17 Advantages and Disadvantages of Powder Metallurgy
18.18 Process Summary
Case Study Steering Gear for a Riding Lawn Mower/Garden Tractor

(This chapter is new and chapter 19 from old ed removed) Chapter 19 Additive Processes: Rapid Prototyping and Direct-Digital Manufacturing
19.1 Introduction
19.2 Rapid Prototyping and Direct-Digital Manufacturing
19.3 Layerwise Manufacturing
19.4 Liquid-Based Processes
19.5 Powder-Based Processes
19.6 Deposition-Based Processes
19.7 Uses and Applications
19.8 Pros, Cons, and Current and Future Trends
19.9 Economic Considerations

(Same chapter in old ed) Chapter 20 Fundamentals of Machining/Orthogonal Machining
20.1 Introduction
20.2 Fundamentals
20.3 Forces (it was Energy) and Power in Machining
20.4 Orthogonal Machining (Two Forces)
20.5 Chip Thickness Ratio (new) (Merchant Model removed)
20.6 Mechanics of Machining (Statics)
20.7 Shear Strain, $g$, and Shear Front Angle
20.8 Mechanics of Machining (Dynamics)
20.9 Summary
Case Study Orthogonal Plate Machining Experiment at Auburn University

(Same chapter in old ed) Chapter 21 Cutting Tools for Machining
21.1 Introduction
21.2 Cutting Tool Materials
21.3 Tool Geometry
21.4 Tool-Coating Processes
21.5 Tool Failure and Tool Life
21.6 Flank Wear
21.7 Cutting Fluids
21.8 Economics of Machining
Case Study Comparing Tool Materials Based on Tool Life

(Same chapter in old ed) Chapter 22 Turning and Boring Processes
22.1 Introduction
22.2 Fundamentals of Turning, Boring, and Facing Turning
22.3 Lathe Design and Terminology
22.4 Cutting Tools for Lathes
22.5 Workholding in Lathes
Case Study Estimating the Machining Time for Turning

(Same chapter in old ed) Chapter 23 Drilling and Related Hole-Making Processes
23.1 Introduction
23.2 Fundamentals of the Drilling Process
23.3 Types of Drills
23.4 Tool Holders for Drills
23.5 Workholding for Drilling
23.6 Machine Tools for Drilling
23.7 Cutting Fluids for Drilling
23.8 Counterboring, Countersinking, and Spot Facing
23.9 Reaming
Case Study Bolt-down Leg on a Casting

(Same chapter in old ed) Chapter 24 Milling
24.1 Introduction
24.2 Fundamentals of Milling Processes
24.3 Milling Tools and Cutters
24.4 Machines for Milling
Case Study HSS versus Tungsten Carbide Milling

(It is somehow like chapter 27) Chapter 25 Sawing, Broaching, and Other Machining Processes
25.1 Introduction
25.2 Introduction to Sawing (27.6)
25.3 Introduction to Broaching (27.3)
25.4 Fundamentals of Broaching (27.4)
25.5 Broaching Machines (27.5)
25.6 Introduction to Shaping and Planing (27.2)
25.7 Introduction to Filing (27.7)
Case Study Cost Estimating-Planing vs. Milling

(it is like chapter 28 in the old ed) Chapter 26 Abrasive Machining Processes
26.1 Introduction
26.2 Abrasives
26.3 Grinding Wheel Structure and Grade
26.4 Grinding Wheel Identification
26.5 Grinding Machines
26.6 Honing
26.7 Superfinishing
26.8 Free Abrasives
26.9 Design Considerations In Grinding
Case Study Process Planning for the MfE

Chapter 27 Workholding Devices for Machine Tools
27.1 Introduction
27.2 Conventional Fixture Design
27.3 Tool Design Steps
27.4 Clamping Considerations
27.5 Chip Disposal
27.6 Unloading and Loading Time
27.7 Example of Jig Design
27.8 Types of Jigs
27.9 Conventional Fixtures
27.10 Modular Fixturing
27.11 Setup and Changeover
27.12 Clamps
27.13 Other Workholding Devices
27.14 Economic Justification of Jigs and Fixtures
Case Study Fixture versus No Fixture in Milling

( this chapter is chapter 19 with different name) Chapter 28 Nontraditional Manufacturing Processes
28.1 Introduction
28.2 Chemical Machining Processes
28.3 Electrochemical Machining Processes
28.4 Electrical Discharge Machining
Case Study Vented Cap Screws

Chapter 29 Lean Engineering (new chapter Thread removed)
29.1 Introduction
29.2 The Lean Engineer
29.3 The Lean Production System
29.4 Linked-Cell Manufacturing System Design Rules
29.5 Manufacturing System Designs
29.6 Preliminary Steps to Lean Production
29.7 Methodology for Implementation of Lean Production
29.8 Design Rule MT < CT
29.9 Decouplers
29.10 Integrating Production Control
29.11 Integrating Inventory Control
29.12 Lean Manufacturing Cell Design
29.13 Machine Tool Design for Lean Manufacturing Cells
29.14 L-CMS Strategy
Case Study Cycle Time for a Manufacturing Cell

( Same chapter in old ed ) Chapter 30 Fundamentals of Joining
30.1 Introduction to Consolidation Processes
30.2 Classification of Welding and Thermal Cutting Processes
30.3 Some Common Concerns
30.4 Types of Fusion Welds and Types of Joints
30.5 Design Considerations
30.6 Heat Effects
30.7 Weldability or Joinability
30.8 Summary

( Same chapter in old ed ) Chapter 31 Gas Flame and Arc Processes
31.1 Oxyfuel-Gas Welding
31.2 Oxygen Torch Cutting
31.3 Flame Straightening
31.4 Arc Welding
31.5 Consumable-Electrode Arc Welding
31.6 Nonconsumable-Electrode Arc Welding
31.7 Welding Equipment
31.8 Arc Cutting
31.9 Metallurgical and Heat Effects in Thermal Cutting
Case Study Bicycle Frame Construction and Repair

( Same chapter in old ed ) Chapter 32 Resistance- and Solid-State Welding Processes
32.1 Introduction
32.2 Theory of Resistance Welding
32.3 Resistance-Welding Processes
32.4 Advantages and Limitations of Resistance Welding
32.5 Solid-State Welding Processes
(New Case) Case Study Manufacture of an Automobile Muffler

( Same chapter in old ed ) Chapter 33 Other Welding Processes, Brazing, and Soldering
33.1 Introduction
33.2 Other Welding and Cutting Processes
33.3 Surface Modification by Welding-Related Processes
33.4 Brazing
33.5 Soldering
(New case) Case Study Impeller of a Pharmaceutical Company Industrial Shredder/Disposal

Chapter 34 Adhesive Bonding, Mechanical Fastening, and Joining of Nonmetals
34.1 Adhesive Bonding
34.2 Mechanical Fastening
34.3 Joining of Plastics
34.4 Joining of Ceramics and Glass
34.5 Joining of Composites
Case Study Golf Club Heads with Insert

(Chapter 10 in old ed) Chapter 35 Measurement and Inspection
35.1 Introduction
35.2 Standards of Measurement
35.3 Allowance and Tolerance
35.4 Inspection Methods for Measurement
35.5 Measuring Instruments
35.6 Vision Systems for Measurement
35.7 Coordinate Measuring Machines
35.8 Angle-Measuring Instruments
35.9 Gages for Attributes Measuring
Case Study Measuring An Angle (NDT removed)

( Same chapter in old ed ) Chapter 36 Quality Engineering
36.1 Introduction
36.2 Determining Process Capability
36.3 Introduction to Statistical Quality Control
36.4 Sampling Errors (New)
36.5 Gage Capability (new)
36.6 Just in Time/Total Quality Control (new)
36.7 Six Sigma (new)

(36.4 and 36.5 from old ed removed)

36.8 Summary
Case Study Boring QC Chart Blunders

Chapter 37 Surface Engineering
37.1 Introduction
37.2 Abrasive Cleaning and Finishing
37.3 Chemical Cleaning
37.4 Coatings
37.5 Vaporized Metal Coatings
37.6 Clad Materials
37.7 Textured Surfaces
37.8 Coil-Coated Sheets
37.9 Edge Finishing and Burrs
Case Study Dana Lynn's Fatigue Lesson

( New Chapter ) Chapter 38 Micro/Meso/Nano Fabrication Processes
38.1 Introduction
38.2 Additive Processes
38.3 Metrology at the Micro/Meso/Nano Level

Chapter 39 Manufacturing Automation
39.1 Introduction
39.2 The A(4) Level of Automation
39.3 A(5) Evaluation or Adaptive Control
39.4 A(6) Level of Automation and Beyond
39.5 Robotics
39.6 Computer-Integrated Manufacturing Automation =
39.7 Computer-Aided Design =
39.8 Computer-Aided Manufacturing 1=117
39.9 Summary

Chapter 40 NC/CNC Processes and Adaptive Control: A(4) and A(5) Levels of Automation
40.1 Introduction
40.2 Basic Principles of Numerical Control
40.3 Machining Center Features and Trends
40.4 Ultra-High-Speed Machining Centers
40.5 Summary

Chapter 41 Microelectric Manufacturing and Assembly
41.1 Introduction
41.2 How Electronic Products Are Made
41.3 Semiconductors
41.4 How Integrated Circuits Are Made
41.5 How the Silicon Wafer Is Made
41.6 Fabricating Integrated Circuits on Silicon Wafers
41.7 Thin-Film Deposition
41.8 Integrated Circuit Packaging
41.9 Printed Circuit Boards
41.10 Electronic Assembly

Chapter 42 Thread and Gear Manufacturing (it is chapter 27 from old ed)
42.1 Introduction
42.2 Thread Making
42.3 Internal Thread Cutting/Tapping
42.4 Thread Milling
42.5 Thread Grinding
42.6 Thread Rolling
42.7 Gear Making
42.8 Gear Types
42.9 Gear Manufacturing
42.10 Machining of Gears
42.11 Gear Finishing
42.12 Gear Inspection

Chapter 43 Nondestructive Inspection and Testing (New Chapter For NDT)
43.1 Destructive versus Nondestructive Testing
43.2 Other Methods of Nondestructive Testing and Inspection

Chapter 44 The Enterprise (Production Systems)
44.1 Introduction
44.2 Axiomatic Design of Systems
44.3 Enterprise System Design Principles
44.4 Functional Areas in the Production System
44.5 Human Resources (Personnel) Department
Selected References for Additional Study S1