This combination progress record and course outline is designed for use by individuals teaching a course in precision sheet metal. Included among the topics addressed in the course are the following: employment opportunities in metalworking, measurement and layout, orthographic projection, precision sheet metal drafting, simple layout, hand tools, bench tools, power machines and equipment, materials, procedures for reading blueprints, layout and development, radial line development, triangulation, fabrication, welding, metal finishing, plastics, safety, customer relations, and business practices. In addition to the theory outline, which includes space for recording information concerning the scheduling and presentation of the lesson material, this record book also contains a list of course objectives for grades 10, 11, and 12 and a grid for use in recording the individual student's mastery of each specific skill taught in the course. (MN)
PROGRESS RECORD
AND
THEORY OUTLINE

PRECISION SHEET METAL

DIVISION OF VOCATIONAL-TECHNICAL SCHOOLS
CONNECTICUT DEPARTMENT OF EDUCATION
1983-1984

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)
This document has been reproduced as received from the person or organization originating it. Minor changes have been made to improve reproduction quality.
Pments of view or opinions stated in this document do not necessarily represent official NIE position or policy.

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)"
GENERAL OBJECTIVE

Student will be able to:

Use their knowledge and skills to satisfactorily perform in the Precision Sheet Metal Trade, as advanced apprentices.
COURSE OBJECTIVES

Grade 10

1. Learn how to read and interpret simple precision sheet metal blueprints.

2. Become proficient in the use and care of measuring tools, hand tools, bench tools.

3. Fabricate projects using standard shop tools and equipment.

4. Determine the gauge, blank size and equality of metals used in precision sheet metal.

5. Do basic Oxy-Acetylene brazing. Know operational features of equipment, procedures and safety practices. Do brazing with gas equipment.

6. Recognize safety hazards and practice all safety precautions.

Grade 11

1. Work with cold rolled steel, stainless steel, aluminum and other metals used in precision sheet metal work.

2. Read blueprints and know symbols and abbreviations.

3. Understand development by using radial line development for tapered parts.

4. Use power equipment, know the parts, proper maintenance and safety features.

5. Practice Electric Arc Welding. Understand the use of various types of arc welding equipment and supplies.

6. Use plane figures for development and geometric construction.

7. Recognize safety hazards and practice all safety precautions.
Grade 12

1. Practice Mig Welding. Know how to use and set up mig welding equipment and supplies.

2. Practice Tig Welding. Set up and operate heli-arc equipment.

3. Interpret advanced blueprints for precision sheet metal parts.

4. Become proficient in the use of all precision sheet metal equipment available.

5. Know the application and use of plastics in precision sheet metal.

6. Draw and develop patterns using Triangulation.

7. Use precision power equipment, know parts, proper maintenance, safety features, and set up same.

8. Know degreasing and painting procedures.

9. Recognize safety hazards and practice all safety precautions.
<table>
<thead>
<tr>
<th>MEASUREMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Read Scale (64ths, 32nds)</td>
</tr>
<tr>
<td>Read Protractor</td>
</tr>
<tr>
<td>Interpret Geometric Construction Probs.</td>
</tr>
<tr>
<td>Read 1000's Scale</td>
</tr>
<tr>
<td>Compute Bend Allowances</td>
</tr>
<tr>
<td>ORTHOGRAPHIC PROJECTION</td>
</tr>
<tr>
<td>-------------------------</td>
</tr>
<tr>
<td>Read Three-View Drawings</td>
</tr>
<tr>
<td>Read Sectional Views</td>
</tr>
<tr>
<td>Read Auxiliary View</td>
</tr>
<tr>
<td>Identify Line, Dimensions</td>
</tr>
<tr>
<td>Draw Three View Drawings</td>
</tr>
<tr>
<td>Draw Sectional Views</td>
</tr>
<tr>
<td>Draw Auxiliary Views</td>
</tr>
<tr>
<td>Draw Cone and Pyramid</td>
</tr>
<tr>
<td>Identify Relationship of positions</td>
</tr>
<tr>
<td>Layout Geometric Construciton</td>
</tr>
<tr>
<td>Simple Layout Work</td>
</tr>
<tr>
<td>--------------------</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>HAND TOOLS - BENCH TOOLS</td>
</tr>
<tr>
<td>---------------------------</td>
</tr>
<tr>
<td>Scribe Metal use Steel Rule</td>
</tr>
<tr>
<td>Scribe Rt. Angle with Steel Square</td>
</tr>
<tr>
<td>Scribe V/N/ lines use Comb. Square</td>
</tr>
<tr>
<td>Center Punch a Point</td>
</tr>
<tr>
<td>Prick Punch a Point</td>
</tr>
<tr>
<td>Swing Arc with Dividers</td>
</tr>
<tr>
<td>Cut Steel using Hacksaw</td>
</tr>
<tr>
<td>File Metal Edges Smooth</td>
</tr>
<tr>
<td>Pop Rivet a Seam</td>
</tr>
<tr>
<td>Measure with Height Gauge</td>
</tr>
<tr>
<td>Measure with Micrometer</td>
</tr>
<tr>
<td>Check Blank Size/ Vernier Caliper</td>
</tr>
<tr>
<td>Measure with Diameter Tape</td>
</tr>
<tr>
<td>Rivet Seams</td>
</tr>
<tr>
<td>Drill Holes with Power Drill</td>
</tr>
</tbody>
</table>

- J

- File Metal Edges
  Smooth

- Power Drill
<table>
<thead>
<tr>
<th>Cut with Unishear</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tap Holes</td>
</tr>
<tr>
<td>Check Part with</td>
</tr>
<tr>
<td>Surface Plate</td>
</tr>
<tr>
<td>Cut using</td>
</tr>
<tr>
<td>Squaring Shear</td>
</tr>
<tr>
<td>Cut, Use Front-</td>
</tr>
<tr>
<td>Side-Back Gage</td>
</tr>
<tr>
<td>Use Standard</td>
</tr>
<tr>
<td>Hand Brake</td>
</tr>
<tr>
<td>Locate Bend Lines</td>
</tr>
<tr>
<td>Bend Metal</td>
</tr>
<tr>
<td>Set Radius Allow-</td>
</tr>
<tr>
<td>ance Bend Metal</td>
</tr>
<tr>
<td>MACHINES &amp; EQUIPMENT</td>
</tr>
<tr>
<td>-----------------------</td>
</tr>
<tr>
<td>Tighten Bend &amp; Clamp Tension</td>
</tr>
<tr>
<td>Change Bending Dies</td>
</tr>
<tr>
<td>Adjust/Set Finger/ Pan Brake</td>
</tr>
<tr>
<td>Bend Sides of a Box</td>
</tr>
<tr>
<td>Set Stops on Notcher</td>
</tr>
<tr>
<td>Install Punch &amp; Die with Foot Press</td>
</tr>
<tr>
<td>Install Punch &amp; Die with Metal Press</td>
</tr>
<tr>
<td>Align Punches, use Nibbling Machine</td>
</tr>
<tr>
<td>Shear, Slit, Notch with Comb. Noter.</td>
</tr>
<tr>
<td>Coper Shear</td>
</tr>
<tr>
<td>Read Drawings</td>
</tr>
<tr>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>Interpret Principles</td>
</tr>
<tr>
<td>Identify Features &amp; Symbols</td>
</tr>
<tr>
<td>Visualize a Metal Part</td>
</tr>
<tr>
<td>Read Unit Assembly Drawings</td>
</tr>
<tr>
<td>Estimate Weight/Sheet Stock</td>
</tr>
<tr>
<td>RADIAT. LINE DEVELOPMENT WORK</td>
</tr>
<tr>
<td>--------------------------------</td>
</tr>
<tr>
<td>Layout Frustrum of Cone</td>
</tr>
<tr>
<td>Sweep a Topper</td>
</tr>
<tr>
<td>Roll Cone Use Slip Rolls</td>
</tr>
<tr>
<td>Layout Tapered Joint</td>
</tr>
<tr>
<td>Use Dia Tape</td>
</tr>
<tr>
<td>Divide Arcs, Circles</td>
</tr>
<tr>
<td>Layout Cone Cut at Angle</td>
</tr>
<tr>
<td>Constructs, identify parts of triangle</td>
</tr>
<tr>
<td>----------------------------------------</td>
</tr>
<tr>
<td>Layout trz sides</td>
</tr>
<tr>
<td>Tapering</td>
</tr>
<tr>
<td>Layout with carpenter square</td>
</tr>
<tr>
<td>Roll use brake</td>
</tr>
<tr>
<td>Dev. vert. tapered square to round</td>
</tr>
<tr>
<td>Layout square to round</td>
</tr>
<tr>
<td>Triangulate a cone</td>
</tr>
<tr>
<td>POWER EQUIPMENT</td>
</tr>
<tr>
<td>----------------</td>
</tr>
<tr>
<td>Use Power Shear</td>
</tr>
<tr>
<td>Use Power Brake</td>
</tr>
<tr>
<td>Clean/Change Electrodes</td>
</tr>
<tr>
<td>Set Machine for var. Gage Material</td>
</tr>
<tr>
<td>Spot Weld Several Gages Together</td>
</tr>
<tr>
<td>Test Weld Strength by Bending</td>
</tr>
<tr>
<td>Check Weld Penetration</td>
</tr>
<tr>
<td>Prepare Metal for Spot Welder</td>
</tr>
<tr>
<td>Repair Bad Spots Welds</td>
</tr>
<tr>
<td>Set Drill Speeds</td>
</tr>
<tr>
<td>Burr Holes</td>
</tr>
<tr>
<td>Counter Drill</td>
</tr>
<tr>
<td>Grind Punches</td>
</tr>
<tr>
<td>Sharpen Drills</td>
</tr>
<tr>
<td>Dress Wheels</td>
</tr>
<tr>
<td>POWER EQUIPMENT</td>
</tr>
<tr>
<td>-----------------</td>
</tr>
<tr>
<td>Install Blades</td>
</tr>
<tr>
<td>Saw Flat Stock</td>
</tr>
<tr>
<td>Set Upper and Lower Die</td>
</tr>
<tr>
<td>Bend Metal 30°-90°</td>
</tr>
<tr>
<td>Flatten Stamp &amp; Crossbend</td>
</tr>
<tr>
<td>Punch Louvers</td>
</tr>
<tr>
<td>Make Radius Bends</td>
</tr>
<tr>
<td>Install Punch &amp; Die</td>
</tr>
<tr>
<td>Make and Mount Strippers</td>
</tr>
<tr>
<td>Punch Holes, All Sizes</td>
</tr>
<tr>
<td>Sear Metal Using Gauges</td>
</tr>
<tr>
<td>Setup/Use Power Roll</td>
</tr>
<tr>
<td>Punch Round Square Holes</td>
</tr>
<tr>
<td>Use Portable Grinder</td>
</tr>
<tr>
<td>17</td>
</tr>
<tr>
<td>----</td>
</tr>
<tr>
<td>Set Oxy-acetylene Equipment</td>
</tr>
<tr>
<td>Braze Light Gage Metal</td>
</tr>
<tr>
<td>Prepare Metal To Weld</td>
</tr>
<tr>
<td>Set Welding Equipment</td>
</tr>
<tr>
<td>Braze Parts</td>
</tr>
<tr>
<td>Form Metal Using Torch</td>
</tr>
<tr>
<td>Set Torch Carbonize</td>
</tr>
<tr>
<td>Neutralize/Oxidize Flames</td>
</tr>
<tr>
<td>Procedure</td>
</tr>
<tr>
<td>----------------------------------</td>
</tr>
<tr>
<td>Set up Equipment</td>
</tr>
<tr>
<td>Select Electrodes</td>
</tr>
<tr>
<td>Strike an Arc</td>
</tr>
<tr>
<td>Run Flat Beads</td>
</tr>
<tr>
<td>Run Butt Welds</td>
</tr>
<tr>
<td>Run Fillet Welds</td>
</tr>
<tr>
<td>Weaving/Whip Motion</td>
</tr>
<tr>
<td>Run Vertical Beads</td>
</tr>
<tr>
<td>Identify Metal</td>
</tr>
<tr>
<td>Control Distortion</td>
</tr>
<tr>
<td>Read Symbols</td>
</tr>
<tr>
<td>Test and Inspect</td>
</tr>
<tr>
<td>Set up Equipment</td>
</tr>
<tr>
<td>------------------</td>
</tr>
<tr>
<td>Set Slope</td>
</tr>
<tr>
<td>Set Wire Feed</td>
</tr>
<tr>
<td>Run Welds</td>
</tr>
<tr>
<td>10/83</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>PLASTICS</td>
</tr>
<tr>
<td>----------</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>SPRAY PAINTING</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
TRADE THEORY OUTLINE

I. TRADE INTRODUCTION AND OPPORTUNITIES

II. MEASUREMENT AND LAYOUT

III. ORTHOGRAPHIC PROJECTION

IV. PRECISION SHEET METAL DRAFTING

V. SIMPLE LAYOUT

VI. HAND TOOLS - LAYOUT TOOLS

VII. BENCH TOOLS

VIII. MACHINES AND EQUIPMENT: BENCH AND FLOOR PRECISION EQUIPMENT

IX. MATERIALS: STEEL AND STEEL STOCK, ALLOYS

X. MATERIALS: FASTENERS, ALUMINUM, STAINLESS STEEL

XI. BLUEPRINT READING SYMBOLS

XII. LAYOUT AND DEVELOPMENT

XIII. RADIAL LINE DEVELOPMENT

XIV. TRIANGULATION

XV. MACHINES AND EQUIPMENT: POWER EQUIPMENT

XVI. FABRICATION: CONE, SQUARE TO ROUNDS, ROUND TO ROUND

XVII. WELDING: OXYACETYLENE

XVIII. WELDING; ELECTRIC ARC

XIX. WELDING; MIG

XX. WELDING: TIG

XXI. METAL FINISHING

XXII. MATERIALS: PLASTICS

XXIII. SAFETY

XXIV. CUSTOMER RELATION AND BUSINESS PRACTICES
I. TRADE INTRODUCTION AND OPPORTUNITIES

A. History of the Trade
   1. Guilds
   2. Apprenticeship
   3. Management

B. Scope of Trade
   1. Job shops
   2. Manufacturing companies
   3. Shipbuilding
   4. Aircraft
   5. Defense
   6. Communications
   7. Welding
   8. Others

C. Trade Opportunities
   1. Machine operators
   2. Metal finishers
   3. Fabricators
   4. Assembly
   5. Set up
   6. Inspectors
   7. Model makers

D. Qualifications
   1. High level of mechanical ability, dexterity
   2. Resourcefulness in solving problems
   3. Blueprint reading ability
   4. Pride in workmanship

II. MEASUREMENT AND LAYOUT

A. Linear Measurement
   1. Units; foot, inch
   2. Fraction and decimal divisions
   3. Rules, steel scale
   4. Dia tape

B. Scale Measurement
   1. Graduations of scales
   2. Measure lines
   3. 1000's scale, decimals
C. Angular Measurement
   1. Terminology
   2. Units: degrees, minutes, seconds
   3. Symbols
   4. Protractor
   5. Measuring angles

D. Geometric Constructions
   1. Terminology
   2. Bisecting lines, angles
   3. Polygons within a circle
   4. Triangles
   5. Tangents

E. Precision Sheet Metal Math

III. ORTOGRAPHIC PROJECTION

A. Terms, Definitions

B. Views
   1. Plan, front, end
   2. Glass cage relationships
   3. Three view drawing
   4. Orthographic vs pictorial
   5. Sectional views, auxiliary views

C. Lines, Identifications
   1. Solid, heavy outlines (primary lines)
   2. Light lines, projection lines
      (secondary lines)
   3. Dashes, center lines, break lines
   4. ASA line conventions

D. Planes, Theory of Projection
   1. Viewing positions (eye level)
   2. Imaginary, horizontal lines
   3. Cutting planes

E. True Lengths of Lines
   1. Foreshortened views
IV. PRECISION SHEET METAL DRAFTING

A. Title Block and Title Strip
   1. Name and address of company
   2. Name of part
   3. Serial prefix
   4. Scale

B. Drawing a Metal Part
   1. Three views

C. Develop Specifications

D. Make Changes and Revisions

V. SIMPLE LAYOUT WORK, INCLUDING PRECISION TEMPLATES

A. Introduction
   1. Layout work

B. Types of Layout and Development
   1. Simple layout
   2. Radial line development
   3. Triangulation

C. Mechanical Drawing Equipment
   1. Drawing board, T-square, angles
   2. Scale rule (1000's)
   3. Pencils (H) compass
   4. Protractor
   5. Etc.

D. Using Drawing Equipment
   1. Position drawing board
   2. Tape corners
   3. Pull tight, straighten
   4. Placement and movement of T-square
   5. Types, use of triangles
   6. Tilt pencil in, sharpening pencils
   7. Use of bow compass
   8. Scale rule
   9. Protractor
E. Development of Patterns

1. Computation of stretchout
   a. Views required for square, rectangular jobs
   b. Rules for development
   c. Formulas
   d. Stretchouts
   e. Seams
   f. Bend radius allowance

2. Stretchout of a box
   a. Views
   b. Formula
   c. Rule
   d. Stretchout
   e. Bend allowance
   f. Notches

3. Stretchout of circular jobs
   a. Views
   b. Rule
   c. Formula
   d. Pi
   e. Stretchout

F. Fabrication of Patterns

1. Layout tools
2. Bend and assemble

G. Computing Sizes of Materials

1. Find size of materials needed for precision parts

H. Precision Template Work

1. Proper lengths
2. Blank sizes
3. Define parts
4. Series of bends
VI. HAND TOOLS - LAYOUT TOOLS

A. Description and Use of Layout Tools

1. Scratch awl
2. Prick punch
3. Straight edge
4. Flat steel square
5. Combination square
6. Center punch
7. Dividers
8. Trammel points
9. Height gage
10. Micrometer
11. Vernier caliper
12. Diameter tape
13. Dial indicators
14. Others

B. Using Layout Tools

1. Scribing a line on metal
2. Laying out right angles with a steel square
3. Scribing vertical line with combination square
4. Scribing horizontal edgelines with combination square
5. Marking with prick punch and center punch
6. Setting and using dividers, trammel points
7. Measure blank size with vernier calipers
8. Check dia with dia tape

VII. BENCH TOOLS

A. Hammers

1. Safety
2. Uses
3. Ball peen, mallets

3. Vises, Clamps

1. Safety
2. Removable jaws, use of vises
3. C-clamps, parallel clamps
C. Hand Hacksaw
   1. Safety
   2. Use, blades, teeth
   3. Angle of cut

D. Small Tools
   1. Safety
   2. All small hand tools such as screwdrivers, wrenches, files, pliers, vice grips, pop-rivet gun, tapping sets, etc.

E. Surface Plate
   1. Use to check flat
   2. Use with dial indicator
   3. Use with height gage

F. Power Tools
   1. Safety
   2. Drills; uses, parts, drill bits, sizes
   3. Unishears: uses, parts, adjust blades, maintenance
   4. Portable grinder

VIII. MACHINES AND EQUIPMENT - BENCH, FLOOR, PRECISION

A. Standard Hand Brake
   1. Safety
   2. Use, tynes, gauge, capacity, adjustments, parts
   3. Set for radius bends
   4. Change blades

B. Pan and Box Brake
   1. Safety
   2. Advantages

C. Squaring Shear
   1. Safety
   2. Types, gauges, use, parts
   3. Blades adjustment, maintenance
   4. Correct user stance, operation
   5. Front, back, side gauges
D. Slip Roll Former
   1. Safety
   2. Use, parts
   3. Adjustment of rolls
   4. Rolling tapered fittings

E. Notcher
   1. Safety: watch hands while operating machine
   2. Set stops
   3. Size of notch

F. Foot Press
   1. Safety: coordinate foot and hand movements
   2. Check stripper plates
   3. Tighten die shoe bolts
   4. Check alignments
   5. Check ram adjustment

G. Hand Metal Punch and Cam Press
   1. Safety: keep hands away from punch
   2. Match punch and die sizes
   3. Change stripper plate with dies
   4. Center punch in die carefully
   5. Depth adjustments
   6. Compensate for wear by removing gib shims

H. Nibbling Machine
   1. Safety: protect eyes
   2. Hand cutting an edge
   3. 1/32 - 1/16 at bottom of stroke
   4. Avoid vibration, secure stock
   5. Starting hole for inside circles
   6. Outside edge cuts
   7. Square inside slots

I. Comb. Notcher, Coper, Shear
   1. Safety: Protect eyes and hands
   2. Set for .002" clearance
   3. "Pierce" or "splay" cutting
   4. Open throat
IX. MATERIALS: STEEL, STEEL STOCK, ALLOYS

A. Properties of Steel
   1. Strength, ductility, hardness, etc.
   2. Corrosion resistance
   3. Galvanizing process

B. Description: Use of Alloys
   1. Gauges, sizes, weights
   2. U. S. Standard gage
   3. Trade name, manufacturers
   4. Grades, types, paintability
   5. Manufacturer's charts, tables, slide charts

C. Steel Stock
   1. Cold rolled sheets, black iron
   2. Band iron, flat bar
   3. Wire, rod
   4. Angle iron, etc.

X. MATERIALS

A. Fasteners
   1. Sheet metal screws
   2. Machine bolts and nuts
   3. Rivets

B. Aluminum
   1. Properties
   2. Processes
   3. Uses
   4. Determining gage, weight, and thickness

C. Stainless Steel
   1. Properties
   2. Processes
   3. Uses
   4. Determining gage, weight and thickness

D. Black Iron
   1. Properties
   2. Processes
   3. Uses
   4. Determining gage, weight and thickness
E. Galvanized Iron
  1. Properties
  2. Processes
  3. Uses
  4. Determining gage, weight and thickness

F. Copper
  1. Properties
  2. Processes
  3. Uses
  4. Determining gage, weight and thickness

G. Hasp, Hinges, Catches
  1. Type required
  2. Inside, outside, piano
  3. With or without lock
  4. Number needed

XI. BLUEPRINT READING

A. Measurement
  1. Inch rule and fractional decimals
  2. Use of rules and square
  3. Angular measurement

B. Drawing
  1. Orthographic projection
  2. Precision drawings

C. Symbols
  1. Drafting symbols
  2. Welding symbols

D. Sheet Metal Shop Procedures
  1. Material weight and thickness
  2. Estimating methods
XII. LAYOUT AND DEVELOPMENT

A. Development Plane Figures
   1. Trapezoids
   2. Angles
   3. Circles

B. Developing Transition Parts
   1. Transition joint
   2. Transition offset

XIII. RADIAL LINE DEVELOPMENT

A. Principles
   1. Determining apex and vertex
   2. Slant heights and true lengths
   3. Views needed for radial line development

B. Need for Radial Line Development
   1. Cones
   2. Reducers and increasers
   3. Hoppers

C. Methods
   1. Step off methods
   2. Strap method

D. Conical Shaped Jobs
   1. Stretchouts
   2. Determining radius
   3. Elements of a cone

E. Pyramid Shaped Jobs
   1. Order of sides in stretchout
   2. Brake lines

F. Pieced Jobs
   1. Jobs requiring two or more patterns

G. Taper on a Pitch
   1. Miter lines
   2. Sweeping a taper
XIV. TRIANGULATION

A. Principles of Triangulation
   1. Radial line principles
   2. Determining the number of true lengths required

B. Triangle Used in Triangulation
   1. True length triangles
   2. Using the altitude, base, and hypotenuse

C. Views Used in Triangulation
   1. Plan
   2. Elevation
   3. Working views
   4. Foreshortened views

D. Patterns
   1. Transferring measurement to patterns
   2. One, two and four pieced patterns

E. Square to Rounds
   1. Centered square to round
   2. Square to round on a pitch
   3. Square to round off center

F. Oblong Fittings
   1. Determining center and flats
   2. Center flair
   3. Oblong to round
   4. Oblong to square

XV. POWER EQUIPMENT

A. Spot Welder
   1. Safety
      a. Guard
      b. Glasses
      c. Checking leakage to ground
   2. Electrodes
      a. Selecting electrodes
      b. Cleaning and filing electrodes
3. Settings
   a. Timer setting
   b. Setting ampere regulator
   c. Cooling pressure

4. Cycle
   a. Cycle of induction welding
   b. Heat
   c. Time
   d. Pressure

5. Capacities
   a. Materials and gages

6. Welds and penetration
   a. Types of spot welds
   b. Checking penetration

7. Maintenance

B. Drill Press
1. Safety
   a. Glasses
   b. Guards

2. Adjustments and settings
   a. Cutting speeds
   b. Pulley adjustments
   c. Chuck and drill sizes
   d. Stop adjustments

3. Hold down equipment
   a. Vises
   b. Parallel bars

4. Maintenance
   a. Lubrication

C. Grinder
1. Safety
   a. Glasses
   b. Shields

2. Grinding Wheels
   a. Grain
   b. Structure
   c. Silican carbide
   d. Aluminum oxide
   e. Abrasives
   f. Grade and bond
3. Mounting the Wheel
   a. Using proper bushing
   b. Balancing
   c. Using correct wheels
   d. Checking for true

4. Wheel dressers
   a. Use types
   b. Maintaining wheel properly

D. Bandsaw
1. Safety
   a. Glasses
   b. Guards

2. Blades
   a. Sizes
   b. Types
   c. Grades
   d. Teeth

3. Adjustments
   a. Speed
   b. Tension
   c. Feed
   d. Blade

4. Blade welder
   a. Fitting and blade ends
   b. Setting blade welder
   c. Welding blade

5. Maintenance
   a. Lubrication

E. Power Hack Saw
1. Safety
   a. Glasses
   b. Guards

2. Adjustments
   a. Blade
   b. Speeds

3. Blades
   a. Types and Sizes

4. Capacities
   a. Stock

5. Maintenance
F. Power Press Brake

1. Safety
2. Loosen and tighten set screws
3. Bring ram down manually
4. Bottom dies for accuracy
5. Avoid off center loading
6. Set multi-bend controls
7. Metal thickness
8. Type of material
9. Angle to be bent
10. Radii needed
11. Maintenance

G. Turret Punch Press

1. Safety
2. Engage guide pin
3. Line up punch and die
4. Maintenance

H. Power Squaring Shear

1. Safety
2. Shear operation
3. Set back and front gauge
4. Maintenance

I. Punch Press

1. Safety
2. Check punch and die alignment
3. Maintenance

J. Sheet Metal Fabricator

1. Safety
2. Types and uses of machines
3. Maintenance

K. Duplicator

1. Safety
2. Types and use of machines
3. Maintenance

L. H/C Fabricator

1. Safety
2. Types and use of machine
3. Maintenance

- 36 -
XVI. FABRICATION

A. Cones
   1. Frustrum of a cone

B. Square to rounds
   1. Square to round on center
   2. Square to round to one side

C. Rounds to rounds
   1. Round equal taper joint
   2. Round taper, one side straight

SVII. WELDING OXY-ACETYLENE

A. Oxy-acetylene Equipment
   1. Oxygen and acetylene cylinder const.
   2. Pressure regulator
   3. Welding torch and tips
   4. Welding hoses
   5. Gloves and glasses

B. Welding Procedures and Descriptions
   1. Brazing
   2. Resistance welding
   3. Induction welding
   4. Arc welding
   5. Gas welding
   6. Mig welding
   7. Tig welding

C. Hazards and Safety of Welding
   1. Lighting the torch
   2. Turning off the torch
   3. Adjusting the regulators
   4. Back fire
   5. Flash back
   6. Clothing and glasses
   7. Hose contact with flame

D. Types of Welding
   1. Without rod
   2. With rod
   3. Butt weld
   4. Fillet weld
   5. Fusion welding
   6. Lap welds
E. Welding Procedures and Variables
1. Preparation
2. Tip size
3. Grip
4. Flame setting
5. Angle and distance of torch
6. Rate of travel and manipulation
7. Rod size

F. Flame
1. Carburizing
2. Neutral
3. Oxidizing

XVIII. ARC WELDING

A. History, Background
1. Early use of the arc
2. Progress after WWI
3. Bare electrodes

B. Equipment
1. Power supplies
2. Clothing, personal equipment
3. Ventilation requirements

C. Safety Practices
1. Eye protection, first aid
2. Lenses, hoods, injurious rays
3. Skin protection, gloves, leggings, shoes
4. Electrical dangers, shock, burns, cables
5. Safety procedures: tankes, drums, etc.
6. Clean-up procedures after welding

D. Selection of Electrodes
1. Terms
2. Classification, AWS, ASTM
3. Markings end, spot, group
4. Coating, sheilded rods
5. Polarity
6. Types of rods; Steel, aluminum, stainless, etc.
7. Reading electrode charts and tables
E. Striking an Arc

1. Scratching method
2. Correct arc length
3. Correct amperage
4. Maintaining the arc
5. Rate of travel

F. Welding Operations

1. Falt heads
2. Weaving motion
3. Butt welds
4. Fillet welds

G. Corner and Edge Welds

1. Horizontal
2. Vertical
3. Overhead

H. Identification and Characteristics of Metals

1. Method of identifying metals
   a. Surface appearance
   b. Sound
   c. Spark test
   d. Fracture

2. Melting points for metals and alloys
3. Grain structures
4. Manufacture and characteristics of metal
   a. Iron ore
   b. Gray cast iron
   c. White cast iron
   d. Malleable iron
   e. Wrought iron
   f. Steel

I. Controlling Distortion

1. Expansion and contraction
2. Upsetting
3. Shrinkage forces
4. Intermittent welds
5. Proper welding sequence
6. Clamps jigs
7. Heat
J. Symbols

1. American Welding Society
   a. Basic symbols and location significance
   b. Supplementary symbols

X. Test and Inspection

1. Types and tests and purposes
2. Methods of testing
   a. Tension
   b. Bend
   c. Shear
   d. Break
3. Visual inspection
4. Principles defects
5. Gauge testing

XIX. MIG WELDING

A. Safety
   1. Eye and face protection
   2. Electrical safety precautions
   3. Protective clothing

B. Mig Power Supply
   1. Set voltage
   2. Set slope

C. Wire Feed
   1. Types of wire

D. Gas
   1. Types needed

XX. TIG WELDING

A. Safety
   1. Eye and face protection
   2. Electrical safety precautions
   3. Protective clothing

B. Machine Operation
   1. Gas
   2. Water
   3. Amperage
XXI. METAL FINISHING

A. Degreasing Procedures
   1. Types of coating
   2. Safety
   3. Size of part
   4. Procedure for loading and unloading

B. Spray Painting
   1. Type of thinner
   2. Adjust spray gun and regulator
   3. Right stroke to use
   4. Disassemble and clean spray gun

XXII. MATERIALS: PLASTICS

A. Terms, Definition, History

B. Types
   1. Thermoplastics
      a. Polyvinylchloride PVC
      b. Polyethlene
      c. Acrylic
      d. Acroton ABS
   2. Thermosetting
      a. Polyester
      b. Epoxies
      c. Phenolic

C. Application
   1. Advantages over metal in various industrial uses

D. Welding Plastics
   1. Hot gas method
   2. Preparation sheets
   3. Welding position and procedure
   4. Types of welds

E. Fastening Procedures
   1. Welding
   2. Cementing, adhesives
   3. Riveting
XXIII. SAFETY

A. Eye
   1. Glasses
   2. Shields

B. Correct Dress
   1. Shoes
   2. Hair
   3. Clothing

C. Handling Metal

D. Correct Use of Tools

E. Correct Use of Machines and Equipment

F. Electrical Precautions

G. Safety First and Last

XXIV. CUSTOMER RELATIONS AND BUSINESS PRACTICES

A. Dress and Appearance - First Impressions
   1. Clothing
      a. Neat
      b. Clean
   2. Personal Appearance
      a. Cleanliness
      b. Personal hygiene
      c. Manners
         1. Polite
         2. Tactful

B. Courtesy to the Customer
   1. Telephone communications
      a. Courteous
      b. Sincere
      c. Listen
      d. Never argue but stand on facts
      e. Misunderstanding produces ill will
2. Association in person
   a. Call customer by name
   b. Pronounce name correctly
   c. Efficient service
   d. Brief, thorough
   e. Satisfy complaints
   f. Enthusiasm about company
   g. Enthusiasm about product

C. Customer Psychology
   1. Get the customer's story
   2. Agreement precedes disagreement
   3. Knowledge of product
   4. Ignorance kills customer confidence
   5. Show initiative

D. Business Practices
   1. Maintain good records
      a. Customer files
      b. Service calls
      c. Time spent
      d. Parts used
      e. Billing
      f. Correspondence
      g. Inventory
      h. Service bulletins
      i. Cost (all costs)
      j. Taxes (all taxes)
      k. Gross income
      l. Net profit

E. Ethics
   1. Workmanship
   2. Parts cost
   3. Labor cost
   4. Overhead cost
   5. Promptness
   6. Contractual and implied obligations
   7. Customer consideration
## TEXTS AND REFERENCES

<table>
<thead>
<tr>
<th>TITLE</th>
<th>AUTHOR</th>
<th>PUBLISHER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precision Sheet Metal Shop Practice</td>
<td>Budzik</td>
<td>Howard W. Sams</td>
</tr>
<tr>
<td>Precision Sheet Metal Blueprint Reading</td>
<td>Budzik</td>
<td>Howard W. Sams</td>
</tr>
<tr>
<td>Precision Sheet Metal Mathematics</td>
<td>Budzik</td>
<td>Howard W. Sams</td>
</tr>
<tr>
<td>Precision Sheet Metal Theory</td>
<td>Budzik</td>
<td>Howard W. Sams</td>
</tr>
<tr>
<td>Student Work Books</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Instructors' Guides</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**TEXTS AND REFERENCES**

Bibliography: Sheet Metal

<table>
<thead>
<tr>
<th>TITLE</th>
<th>AUTHOR</th>
<th>PUBLISHER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement &amp; Layout</td>
<td></td>
<td>Delmar</td>
</tr>
<tr>
<td>Hand Process</td>
<td></td>
<td>Delmar</td>
</tr>
<tr>
<td>Machine Process</td>
<td></td>
<td>Delmar</td>
</tr>
<tr>
<td>Job Series</td>
<td></td>
<td>Delmar</td>
</tr>
<tr>
<td>Teacher Manual</td>
<td></td>
<td>Delmar</td>
</tr>
<tr>
<td>Related Information Sheet Metal 1</td>
<td>Johnson</td>
<td>Delmar</td>
</tr>
<tr>
<td>Related Information Sheet Metal 2</td>
<td>Johnson</td>
<td>Delmar</td>
</tr>
<tr>
<td>Related Information Sheet Metal 3</td>
<td>Johnson</td>
<td>Delmar</td>
</tr>
<tr>
<td>Related Information Sheet Metal 4</td>
<td>Johnson</td>
<td>Delmar</td>
</tr>
<tr>
<td>Instructors' Guides 1, 2, 3, 4</td>
<td>Johnson</td>
<td>Delmar</td>
</tr>
<tr>
<td>Quiz &amp; Test Packets, 1, 2, 3, 4</td>
<td></td>
<td>Delmar</td>
</tr>
<tr>
<td>Mathematics for Sheet Metal Fabrication</td>
<td></td>
<td>Delmar</td>
</tr>
<tr>
<td>Instructors' Guide</td>
<td></td>
<td>Delmar</td>
</tr>
<tr>
<td>Sheet Metal Blueprint Reading</td>
<td></td>
<td>Delmar</td>
</tr>
<tr>
<td>Round Layouts</td>
<td>Kaberlein</td>
<td>Bruce</td>
</tr>
<tr>
<td>Triangulation</td>
<td>Kaberlein</td>
<td>Bruce</td>
</tr>
<tr>
<td>Sheet Metal Pattern Drafting</td>
<td>Daughtery &amp; Powell</td>
<td>Bennett</td>
</tr>
<tr>
<td>Sheet Metal Layout</td>
<td>Leo A. Meyers</td>
<td>McGraw-Hill</td>
</tr>
<tr>
<td>Sheet Metal Simplified Volumes I, II, III</td>
<td>Reid</td>
<td>Edwards</td>
</tr>
<tr>
<td>Sheet Metal Shop Practice</td>
<td>Bruce &amp; Meyer</td>
<td>Amer. Tech. Soc.</td>
</tr>
<tr>
<td>Oxy-Acetylene Welding</td>
<td></td>
<td>Delmar</td>
</tr>
<tr>
<td>Basic Arc Welding</td>
<td></td>
<td>Delmar</td>
</tr>
<tr>
<td>Gas &amp; AC Arc Welding &amp; Cutting</td>
<td>Jennings</td>
<td>McKnight</td>
</tr>
<tr>
<td>Arc Welding Lessons</td>
<td>Kugler</td>
<td>Lincoln Co.</td>
</tr>
<tr>
<td>Metals &amp; How to Weld Them</td>
<td>Jefferson &amp; Woods</td>
<td>Lincoln Co.</td>
</tr>
</tbody>
</table>
CATALOGS - MANUALS - CHARTS

International Acetylene Association
30 East 42nd Street
New York, N. Y.

Safe Practices for Installation and Operation of Oxy-Acetylene Welding and Cutting Equipment
Welding Codes and Specifications
Oxy-Acetylene and Its Applications
Bronze Welding or Brazing by Oxy-Acetylene
Miscellaneous Uses of Oxy-Acetylene Flame

American Welding Society
33 West 39th Street
New York, N. Y.

Safe Practices Welding and Cutting Containers

Factory Insurance Association
Hartford, Conn.

Preventing Cutting and Welding Fires

Linde Company
300 First Avenue
Needham Heights, Boston, Mass.

Precautions and Safe Practices

TRADE JOURNALS

FMA Journal of the Fabricator
7811 North Alpine Road
Rockford, Illinois 61111
**BIBLIOGRAPHY: Sheet Metal**

<table>
<thead>
<tr>
<th>FILMS</th>
<th>NUMBER</th>
<th>SUPPLIER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot Rolling of Steel Sheets</td>
<td>SU 980</td>
<td>U. S. Steel</td>
</tr>
<tr>
<td>Zinc Controls Corrosion</td>
<td>1627</td>
<td>Modern Talking Pictures</td>
</tr>
<tr>
<td>Build Better with Ramset</td>
<td>2333</td>
<td>Modern Talking Pictures</td>
</tr>
<tr>
<td>Science of Making Brass</td>
<td></td>
<td>Tech. Voc.-Ind. Film</td>
</tr>
<tr>
<td>Copper</td>
<td>S-843</td>
<td>Associated Films</td>
</tr>
<tr>
<td>Oblique Cones &amp; Transition Dev.</td>
<td></td>
<td>Tech. Voc-Ind. Film</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FILMSTRIPS</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxy-Acetylene Welding Series A2 to E3 (15 in set)</td>
<td>Jim Handy Co.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>KIT NO.</th>
<th>TITLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-1</td>
<td>An Introduction to Welding</td>
</tr>
<tr>
<td>A-2</td>
<td>Setting Up &amp; Lighting the Welding Torch</td>
</tr>
<tr>
<td>B-1</td>
<td>Welding Flat Ripples</td>
</tr>
<tr>
<td>B-2</td>
<td>Flat Butt Welds</td>
</tr>
<tr>
<td>C-1</td>
<td>Fillet Welds, Steel</td>
</tr>
<tr>
<td>C-2</td>
<td>Vertical Welds, Steel</td>
</tr>
<tr>
<td>E-1</td>
<td>Oxy-Acetylene Cutting</td>
</tr>
<tr>
<td>E-2</td>
<td>Brazing &amp; Silver Soldering</td>
</tr>
</tbody>
</table>

McGraw-Hill No. 070805 Sheet Metal Laying Out & Cutting

Navy - SN 2330p Transition Piece - Square to Round

<table>
<thead>
<tr>
<th>TRANSPARENCIES</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>McGraw-Hill Mechanical Drawing Series</td>
<td>Unit VII</td>
</tr>
<tr>
<td>Number</td>
<td>Title</td>
</tr>
<tr>
<td>22264</td>
<td>Developing a Cone</td>
</tr>
<tr>
<td>22265</td>
<td>Developing a Pyramid</td>
</tr>
<tr>
<td>22267</td>
<td>Developing a Truncated Cone (irreg. frustrum)</td>
</tr>
<tr>
<td>22268</td>
<td>Developing a Transition Piece (rect. to rd.)</td>
</tr>
<tr>
<td>22269</td>
<td>Developing Intersecting Cylinders</td>
</tr>
</tbody>
</table>

Sheet Metal Series - DCA Education Products

Basics
Hand Tools
Pattern Development
S.M. Fabrication