F. SHOP SKILLS

F1. Display Knowledge of Basic Shop Math

F1.1. Perform the basic arithmetic functions.

Performance Objective: Given an array of numerical problems in the manufacturing process and without the use of a calculator, the student will be able to perform basic addition, subtraction, multiplication, and division, using decimals, fractions, ratios, and percentages with a consistent accuracy of 100%.

Performance Objective: Given drafting paper, drafting tools, calculator, and a list of geometric concepts, the student will be able to draw an example of each concept and provide calculations where necessary.

BASIC GEOMETRIC CONCEPTS		
Straightness	Area/volume	Circularity
Parallel	Tangent	Concentricity
Perpendicular	Symmetry	Arch
Angularity		

F1.2. Translate into dollar cost/value.

Performance Objective: Given a cost-of-materials estimate and a man-hours estimate for a specific job, the student will be able to translate these into a dollar cost/value.

F1.3. Utilize hand calculators.

Performance Objective: Given a calculator and an array of numerical problems in the manufacturing process, the student will be able to perform basic addition, subtraction, multiplication, and division, using decimals, fractions, ratios, and percentages with a consistent accuracy of 100%.

F1.4. Calculate with percents, rate, ratio, and proportion.

Performance Objective: Given a calculator, measurement tools, and two drawings of the same object drawn at different scales, the student will be able to state the proportional difference, state the ratio, and determine the percentage difference in scales between the two drawings.

F1.5. Make reasonable estimates of arithmetic results, determine averages, etc., without a calculator.

Performance Objective: Given the need to produce 30 plywood panels of the same thickness but different heights and widths, and the cost of materials, the student will be able to estimate the average number of panels per 4 x 8-foot sheet with the least amount of waste and estimate the total cost of these materials and the average cost per panel without the use of a calculator.

F2. Show Working Knowledge of Fundamental Shop Skills

F2.1. Possess basic mechanical skills.

Performance Objective: Given basic hand tools, powered and non-powered, and basic shop tasks, the student will be able to safely operate, use, and maintain the tool and perform the tasks according to manufacturer's guidelines.

HAND TOOLS	
NON-POWER	POWER
Screw drivers, hammers, pliers	3/8″ drill
Awl, punch, scribe, vise, level	Skill saw
Hand saws: cross-cut, rip	Saber saw
Sockets	Sander: rotary, belt
Electrical:	Router
Desolder bulb, solder wick	Soldering gun
Open end/box combination wrenches	Welding and cutting torch

BASIC MECHANICAL SKILLS	
Select and use hand tools	
Read blue prints & schematics	Routine tool maintenance
Hand fitting and minor assembly	Shop housekeeping

F2.2. Possess standard machine tool operating skills.

Performance Objective: Given a variety of standard machine tools, the student will be able to demonstrate the operation, use, and maintenance according to manufacturer's guidelines.

POSSIBLE TOOLS TO SATISFY THIS OBJECTIVE (not all required)	
STANDARD MACHINE EQUIPMENT/TOOLS	BASIC PROCESSES
Lathe	Perform turning
Drilling	Perform drilling
Plane	Perform milling
Grinders	Perform surface grinding
Milling	Use fixtures and accessories
Broaching	Choose speed and feed
Gear shaping	Select coolants, lubricants and cutting fluids
Others: Electrical discharge Injection moulding Welding Robots	

F2.3. Inspect machinery and equipment.

Performance Objective: Before starting a machining operation and using a provided checklist, the student will be able to determine the safety and fitness of tools, machinery, equipment, and lubrication if required.

F2.4. Interpret safety manual directives.

Performance Objective: Given the safety manual for machinery and equipment, the student will be able to identify all safety features of the machine and state how they protect the user and others in the shop.

F2.5. Follow established safety procedures when around machinery equipment.

Performance Objective: Given the operation of a particular piece of equipment, the student will be able to state and demonstrate both the manufacturer’s safety procedures and the shop’s safety procedures with 100% accuracy.

Performance Objective: When in the machine shop, the student will be able to state and demonstrate safe movement and the use of personal protective equipment such as safety shoes, goggles, and hard hats, and the shop’s safety procedures with 100% accuracy and consistency.

F3. Understand How Tools and Fixtures are Used in Manufacturing

F3.1. Determine replacement and retooling requirements for a variety of machines.

Performance Objective: Given five lathe cutting tools, five drill bits and five saw blades, appropriate gauges, and an opportunity to use or otherwise inspect these tools, the student will be able to correctly determine the needs or replace or retool each based on speed, cutting characteristics, and instructor criteria.

F3.2. Describe the importance of correct fixtures.

Performance Objective: Given particular machining (or assembly or welding) operations, the student will be able to identify the correct fixtures to be used (such as a depth gauge on a drill press), and verbally explain their importance.

F3.3. Design and create fixtures.

Performance Objective: Given part specifications, the need to monitor the amount of pressure on the part during its machining, and provided clamps and required gauge, the student will be able to design a fixture to perform a specified function and effectively use it to meet part specifications.

F4. Demonstrate Use of Common Machine Tools

F4.1. Follow established safety procedures when using machine tools.

Performance Objective: Given the safety manual for a machine tool such as a lathe cutting tool, the student will be able to identify all safety features of the machine, discuss characteristic tool wear and failure, and state how this information can protect the user and others in the shop.

F4.2. Identify a variety of common machine equipment and machine tools.

Performance Objective: Given pictures of current machine tools pertinent to the related curriculum, the student will be able to correctly identify all of them.

COMMON MACHINE EQUIPMENT	
Lathe	Plane
Drill press	Grinders
COMMON MACHINE TOOLS	
Drill and reamer bits	Saw blades

Lathe cutters	Solder tips
Mills	

F4.3. Describe the function of specific machine tools.

Performance Objective: Given a list of specific machines tools, the student will be able to state their functions.

F4.4. Inspect tools for defects.

Performance Objective: Before starting a machining operation and using a provided checklist, the student will be able to determine the safety and fitness of tools, materials, fixtures, and jigs, check for malfunctions and report defects and malfunctions to appropriate personnel.

DEFECTS AND MALFUNCTION CHECKLIST			
Tools	Materials	Fixtures	Jigs
Electric cord	Hardness	Clean fit	Master check
Operating guides	Grain	Easy Movement	First part check
Sharp	Size (rough cut)	Easy to adjust	
Clean	Deburred	Adjustments secure	
Speed			
Light			
Lubrication			

F4.5. Maintain company-provided tools.

Performance Objective: Using the manufacturer’s specification and/or written shop procedures/checklists, the student will be able to establish in writing and follow periodic function checks, including lubrication, during the process of using the equipment over a given period of time.

F5. Demonstrate Basic Skills of Fabricating, Assembling and Testing a Product

F5.1. Locate and retrieve production materials specific to process flow and delivery schedule.

Performance Objective: After studying just-in-time delivery and the timing of the flow of a production process, the student will be able to locate production materials and schedule their delivery into the flow.

F5.2. Receive and communicate process flow instructions and delivery schedules.

Performance Objective: Given a process flow and delivery schedule, the student will be able to successfully explain the process flow and verbally review these materials as judged by those listening to and questioning the presentation.

F5.3. Prepare resources for production.

Performance Objective: Given a process flow and delivery schedule, production rate and production volume, and a layout of a manufacturing shop, the student will be able to locate and allocate human resources, tooling, power outlets, machine equipment, tools, and materials for effective and efficient production as measured by quality improvement processes and compared to a benchmark model.

F6. Demonstrate Proper Use of Basic Metal and Wood-working Tools

F6.1. Operate hand tools in a safe, prescribed manner.

Performance Objective: The student will be able to identify the safety features and demonstrate the safe use of all available shop hand tools according to manufacturers' guidelines.

HAND TOOLS	
NON-POWER	POWER
Screw drivers	3/8" drill
Pliers - locking	Skill saw
Awl, punch, scribe	Saber saw
Hand saws:	Rotary sander
Cross-cut	Belt sander
Rip	Soldering gun
Sockets	Welding and cutting torch
Hammers	Router
Vise	
Level	

F6.2. Inspect tools for defects.

Performance Objective: After studying the manufacturer's manual and performing an operational test, the student will be able to identify any defects in materials and operations of all available shop tools.

F6.3. Maintain company-provided tools.

Performance Objective: Using the manufacturer's specification and/or written shop procedures/checklists, the student will be able to establish in writing and follow periodic function checks during the process of using the tools over a given period of time.

F7. Select Appropriate Tools for Layouts and Inspection From Prints

F7.1. Lay out a part for cutting and drilling.

Performance Objective: Given a piece of aluminum, blueprints, layout marking dye, 6″ dividers, combination set, center punch and a scribe, the student will be able to lay out the part to within ±.015″ of drawing specifications.

F7.2. Interpret prints to determine appropriate tool usage.

Performance Objective: Using a technical drawing and a part layout, the student will be able to select the appropriate tools for forming and cutting the part, including bend allowance.

F8. Demonstrate Basic Electrical Wiring Skills

F8.1. Interpret drawings/schematics.

Performance Objective: After studying basic electrical circuits and symbols of related components and given an electrical schematic drawing, the student will be able to list all components required for production with 100% accuracy.

BASIC ELECTRICAL COMPONENTS		
Wire connections	Wire crosses	Batteries
Switches	Lamps	Connectors
Antennas	Speakers	Microphones
Fuses	Motors	Relays
Capacitors	Potentiometer	Rheostat
Resistors	Coils	Transformers
Diodes	Transistors	Amplifiers
Logic gates		

F8.2. Follow electrical troubleshooting procedures.

Performance Objective: Given an electrical schematic drawing and appropriate test equipment, the student will be able to follow troubleshooting procedures to identify the problem in the circuit.

FOUR-STEP TROUBLESHOOTING METHOD
1. Identify and isolate symptoms
2. Determine the defective block or stage
3. Determine defective components in the block
4. Repair, replace, and test

F8.3. Use appropriate equipment to monitor power supply.

Performance Objective: Given an adjustable, non-regulated power supply and test equipment, the student will be able to monitor the constancy of output voltage supplied to shop equipment.

FOUR-STEP TROUBLESHOOTING METHOD
1. Identify and isolate symptoms
2. Determine the defective block or stage
3. Determine defective components in the block
4. Repair, replace, and test

F9. Identify Tools and Procedures to Form, Cut, Finish, Fasten, and Repair

F9.1. Differentiate between types of tools.

Performance Objective: Given ten different tasks to perform, the student will be able to choose the appropriate tool and state what characteristics of the tools fits each of the tasks.

TOOLS			
FORMING	CUTTING	FINISHING	FASTENING
Lathe	Saws:	Belt sander	Rivet gun
Plane	Table	Disk sander	Bucking bar
Press	Band	Grinder	Counter sink
Joggle	Scroll	Polisher	Cleco
Brake	Saber	Etching*	Welding torch
Grinder	Hand Circular	Etching printed circuits*	Soldering gun Spot rivet
Molds	Shears/scissors	Deburr	Taps and dies
Castings	Drill press	Sand blasting	
Router	Cutting torch	Painting*	
CNC machine	Knives, chisels	Spray	C-clamps
Fixtures, jigs	Fixtures, jigs	Beed blasting	Fixtures, jigs

F9.2. Identify the function of each.

Performance Objective: Given any tool, the manufacturer’s handbook (when appropriate)and a verbal presentation, the student will be able to successfully state the functions it was designed to perform and point to the characteristics that support the function.

F10. Demonstrate Fundamentals of Chemical Processes in Manufacturing

F10.1. List the common properties of metal.

Performance Objective: Given the need to select a metal for part construction, the student will be able to list ten properties of metals that should be considered.

BASIC METAL PROPERTIES		
Thickness	Density	Shear strength
Tensile strength	Compressive strength	Corrosivity
Malleability	Melting point	Flammability
Thermal expansion	Specific heat	Hardness
Thermal conductivity		Electrical conductivity and magnetism
Hardenability	Yield strength	Modulus of elasticity

F10.2. Define metal terms.

Performance Objective: The student will be able to define pure metals, ferrous alloys, non-ferrous alloys and give examples of each.

PURE METALS	FERROUS ALLOYS	NON-FERROUS ALLOYS
Iron	Steel (low alloy-SAE)	Aluminum
Copper	Stainless steel	Copper
Lead	Carbon steel	Nickel
Silver	Cast iron	Titanium
Gold	Tool steel	
Aluminum		
Zinc		

F10.3. List the types of chemical and manufacturing processes.

Performance Objective: After studying the contributions of chemistry to the manufacturing process, the student will be able to identify two major chemical manufacturing processes as well as list chemically produced materials, chemical treatments, and coatings.

CHEMICAL PROCESSES	MANUFACTURING PROCESSES
Chemical machining	General processes:
Chemical milling	Designing
Reagents and etchants	Tooling
Electro-chemical machining	Production
	Assembly
Materials development:	
Plastics:	General production:
Thermoplastics	Machining
Thermosets	Casting
Composites	Forging
Chemical treatment:	Rolling
Cleaning	Extruding
Degreasing	
Etching	Operations and procedures:
Anti-corrosive:	Cutting
Alodine	Forming
Anodize	Finishing
	Fastening
Chemical Coating:	Repairing
Electro plating	
Primers	Other processes (not chemical):
Paints	Electrical discharge machine (EDM)
Vapor deposition	Laser beam machine
Fuels	
Chemical and Drug Manufacturing	

F10.4. Differentiate between types of chemical and manufacturing processes.

Performance Objective: Given an example of a chemical manufacturing and a machine manufacturing process, the student will be able to state their differences and give reasons why a chemical process may be the best process to use.

ADVANTAGES OF A CHEMICAL MANUFACTURING PROCESS
1. If the materials used are very hard & strong - > 400 HB
2. If the work piece is slender and difficult to hold
3. A high surface finish is required
4. Temperature changes are unacceptable
5. Working on a complex part

F11. Know How to Lessen the Need for Layout and Inspections with Work-saving Devices

F11.1. Identify types of work-saving devices utilized in manufacturing.

Performance Objective: Given a list of basic shop operations, the student will be able to suggest what two work-saving devices could be used in each operation.

WORK-SAVING DEVICES	
Part Tooling	Jigs: Miter, spacing, bending
Guides	V-blocks
CNC Machines	Fixtures
Robotics	Computers
	CAD-CAM

F11.2. Describe scenarios in which work saving devices can be utilized.

Performance Objective: Given a blueprint and the need to drill three 1/4″ holes into multiple copies of a flat, irregular-shaped part, the student will be able to design and use a jig and a fixture such that the holes are located within a tolerance of ± .03 inches with no variance among the parts.