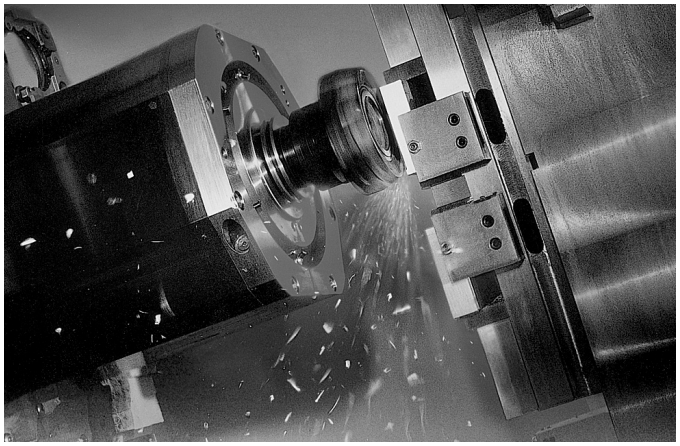

Meeting Certification Standards

As certification standards are fast becoming employment requirements, it is vital that vocational/technical programs cover the skills required by industry. To help plan your program using the ***Machining Fundamentals*** text, the following information, correlation chart, and drawings have been included.

The National Tooling and Machining Association (NTMA) has developed a three level program *(Duties and Standards for Machining Skills)* of National Skill Standards for the Machining Industry. The goal of the NTMA was to establish world-class standards reflecting industry skill requirements. The standards are performance based and at present are voluntary.

The standards will provide a method through certification and training for individual workers to receive recognition and reward for their abilities. The standards will help employers identify training needs and evaluate job applicants fairly.

Elements of all three standards often appear in training programs depending on capabilities available and in certain programs where the concentration of work is in machine specific operations. Due to the scope of ***Machining Fundamentals***, only Level I will be covered in this manual. For additional information regarding the standards and testing programs, contact the National Tooling and Machining Association (NTMA), 9300 Livingston Road, Fort Washington, MD 20744.

Level I Machining Responsibilities

According to the NTMA, an individual with Level I Machining Skills is a skilled machine operator or technician who has demonstrated competence in three major areas of responsibility: basic bench operations, basic metal cutting operations, and basic inspection and quality assurance functions.

This individual can perform these responsibilities in both single and multiple part production. No supervision or training responsibilities of other operators or other production workers is assumed at Level I.

Most Level I skills can be met in six months to one year of education and training, depending on prior manufacturing experience, basic academic skills, mechanical aptitude, and the availability of laboratory-based training. This training could be given in a high school or community college vocational/technical education program, apprenticeship program, formal company training program, or structured on-the-job training.

Each skill set is based on the most important responsibilities that workers are expected to perform and is modular in design—student/trainees, workers, or employers select those from the different skill sets that best meet their career direction or job requirement.

Level I machining responsibilities typically include the ability to: (Note: These are not the standards.)

Bench operations:

- Select and use hand tools.
- Perform basic, routine layout.
- Read and comprehend information on orthographic prints and job process sheets for manufacturing operations.
- Deburr.
- Perform hand fitting and minor assembly.
- Perform bench cutting tasks such as sawing, reaming, and tapping.

- Perform basic, routine preventive maintenance.
- Perform basic housekeeping responsibilities.

Metal cutting operations:

- Identify basic metallic and non-metallic materials.
- Identify and use most accessories and tooling for machining operations.
- Choose an appropriate speed and feed for a given operation.
- Perform basic process planning, setup, and operation of common classes of machine tools such as turning, milling, drilling, or surface grinding machines.
- Select and use cool coolants appropriately.
- Make suggestions for improving basic machining operations within a structured improvement process.
- Be competent in all safety procedures for all machining operations and material handling and disposal within their responsibility.

Inspection and quality assurance responsibilities:

- Use basic precision measurement tools.
- Follow an inspection process plan.
- Perform basic quality assurance responsibilities for both single and multiple part production including statistical process control.

Other competency areas:

- Follow standardized work procedures in a limited range of standardized work contexts under direct supervision.
- Be competent in all basic aspects of seeking and maintaining employment in the metalworking industry.

Duty Framework for Machining Skills—Level I

The following is a complete list of the duty areas and titles that comprise the NTMA's Level I machining skills. This outline can be used to help ensure that your program includes all of the areas identified.

1. Job Planning and Management
- 1.1 Job Process Planning

2. Job Execution
- 2.1 Manual Operations Benchwork
- 2.2 Manual Operations Layout
- 2.3 Turning Operations, Between Centers Turning
- 2.4 Turning Operations, Chucking
- 2.5 Power Feed Milling
- 2.6 Vertical Milling
- 2.7a Grinding Wheel Safety
- 2.7b Surface Grinding
- 2.8 Drill Press Operations
- 2.9 Power Saws

3. Quality Control and Inspection
- 3.1 Part Inspection
- 3.2 Process Control

4. Process Adjustment and Control
- 4.1 Process Adjustment, Single Part Production*
- 4.2 Participation in Process Improvement*

5. General Maintenance
- 5.1 General Housekeeping and Maintenance
- 5.2 Preventive Maintenance*
- 5.3 Tooling Maintenance*

6. Industrial Safety and Environmental Protection
- 6.1 Machine Operations and Material Handling*
- 6.2 Hazardous Materials Handling and Disposal*

7. Career Management and Employment Relations
- 7.1 Career Planning
- 7.2 Job Applications and Interviewing*
- 7.3 Teamwork and Interpersonal Relations*
- 7.4 Organizational Structures and Work Relations*
- 7.5 Employment Relations*

* *These duty titles are beyond the scope of the text and have been omitted from the correlation chart.*

In addition to basic machining skills, students/trainees must also master basic communication, math, measurement, and drawing skills. The basic skills listed below are correlated to the duty areas by number.

1. Written and Oral Communications
- 1.1 Reading
- 1.2 Writing
- 1.3 Speaking
- 1.4 Listening

2. Mathematics
- 2.1 Arithmetic
- 2.2 Applied Geometry
- 2.3 Applied Algebra
- 2.4 Applied Trigonometry
- 2.5 Applied Statistics

3. Decision Making and Problem Solving
- 3.1 Applying Decision Rules
- 3.2 Basic Problem Solving

4. Group Skills and Personal Qualities
- 4.1 Group Participation and Teamwork
- 4.2 Personal Qualities

5. Engineering Drawings and Sketches
- 5.1 Standard Orthographic Prints
- 5.2 GDT Orthographic Prints

6. Measurement
- 6.1 Basic Measuring Instruments
- 6.2 Precision Measuring Instruments
- 6.3 Surface Plate Instruments

7. Metalworking Theory
- 7.1 Cutting Theory
- 7.2 Tooling
- 7.3 Material Properties
- 7.4 Machine Tools
- 7.5 Cutting Fluids and Coolants

Prints for Developing Level I Skills

The prints included on pages 27–37 of this resource were developed by the author in the attempt to fulfill requirements for the Level I assignments. The prints are correlated to the duty titles by the drawing numbers. Instructors are encouraged to prepare job assignments of their own, or use industrial drawings that will offer the same challenges.

The tolerances noted on the drawings are those recommended by The Metalworking Industry Skills Standards Board.

Although 1018 H.R. steel has been selected for the assignments, cold finished steel, steels of other composition, or other metals can be used.

The following list of materials and tools (identified by duty title number) has been included for your convenience in organizing the materials required for each assignment.

Angle plate, 2.2, 2.7b, 2.8, 3.1
Appropriate population of product matching print specifications (broken up into packages matching requirements of sampling plan), 3.2
Arbor press, 2.1
Ball-peen hammer, 2.2, 2.5, 2.6, 2.8
Bench vise (4″), 2.1
Blade(s), (power saw), 2.9
Boring bar, 2.4
Boring tool (capable of boring to a square shoulder), 2.4
Brooms, 5.1
Brushes, 5.1
C-clamps, 2.2
Center drills, 2.4, 2.8
Center gage, 2.3, 2.4
Chamfer tools (45°), 2.3, 2.4
Clamps, 2.5, 2.6, 2.7b, 2.8, 3.1
Combination drill and countersink, 2.3, 2.6
Combination set, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7b, 2.8, 5.3
Common workbench, 1.1, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7a, 2.7b, 2.8, 3.1, 3.2, 4.1, 5.1, 5.3
Composition hammer, 2.7b, 2.8
Coolants, 2.6
Counterbores, 2.8
Countersink, 2.6, 2.8
Cutter (2″ or larger diameter) that may be a face mill, 2.5
Cutter adaptors, 2.5, 2.6
Cutters (assorted) , 2.5 , 2.6
Cutting fluids, 2.8, 4.1
Cutting oil, 2.6
Dead center fitted to the spindle taper, 2.3
Depth micrometer set, 2.6, 2.7b
Dial indicator, 2.3, 2.4, 2.5, 2.6, 2.7b, 5.3
Diamond dresser, 2.7a, 2.7b
Dividers (6″), 2.2, 2.8
Drill chucks, 2.3, 2.4, 2.6, 2.8
Drill press (Morse taper #3 spindle capacity or greater; tapping capability), 2.8
Drill vise (6″ or greater), 2.8
Drills, 2.4, 2.6, 2.8, 5.3
Edge finder, 2.5, 2.6
Engine lathe (min. 14″ 3 30″ capacity), 2.3, 2.4
EPA guidelines for hazardous material handling and storage, 6.2
External threading tool matched to profile of thread on turning print, 2.3, 2.4
External undercut tools, 2.3, 2.4
Files, 2.3, 2.4, 2.5, 2.6, 2.7b, 2.9
Fishbone charts, 4.2
Flip charts, 4.2
Forty taper spindle or greater, 2.5
4-jaw independent chuck, 2.3, 2.4
Gage blocks (inspection grade), 3.1
Go/no-go gage for threads, 2.8
Grease, 5.2
Grinding wheels (assorted), 2.7a, 2.7b
Hand tools, 2.7a, 5.2
Hazardous materials, 6.2
identification instruments, 6.2
instruments for measuring concentration, 6.2
Inside calipers, 2.4
Inspection tools (basic, fixed, precision, surface plate), 3.1, 3.2, 4.1
Internal threading tool matched to profile of thread on turning print, 2.4

Internal undercut tools, 2.4
Inventory of available tools, 1.1
Layout height gage, 2.2, 2.8, 5.3
Layout ink, 2.2, 2.8
Layout surface plate (min. 12″ × 18″), 2.2
Left-hand turning tool (capable of turning to a square shoulder), 2.3, 2.4
Live center, 2.3
Machine tool, 5.2
Machine tool with setup in use, 4.1
Magnetic base for dial indicator, 2.3, 2.4, 2.5, 2.6, 2.7b, 5.3
Magnetic chuck, 2.7a, 2.7b
Magnifying glass, 2.2
Maintenance forms, 5.2
Markerboard, 4.2
Markers, 4.2
Measuring instruments, 4.2
Micrometers, 2.3, 2.4, 2.5, 2.6, 2.7b, 2.8, 5.3
Mill with power feed on X and Y axes, 2.5
Milling cutter bodies with inserts, 5.3
Milling vise (6″ or greater), 2.5, 2.6
Morse taper sleeves (assorted), 2.8
Nuts, 2.5, 2.6, 2.8
Oil, 5.2
OSHA guidelines, 5.1, 6.1, 6.2
Parallel-closing clamps, 2.2
Parallels (adjustable), 2.5, 2.6, 2.7b
Parallels (assorted), 2.5, 2.6, 2.7b, 2.8
Pedestal grinder, 5.3
Pitch micrometer, 2.3, 2.4
Plug gages, 2.8, 5.3
Power saw, 2.9
Precision grinding vise, 2.7b
Precision surface plate, 2.7a, 2.7b
Prick punch, 2.2, 2.8
Prints and/or matching parts, 1.1, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7b, 2.8, 2.9, 3.1, 3.2, 4.1, 4.2
Quick change gearbox, 2.4
Radius gages, 2.2
Reamers, 2.6, 2.8
Right-hand turning tool (capable of turning to a square shoulder), 2.3, 2.4
Rule (6″), 2.3, 2.4, 2.5, 2.6, 2.7b, 2.8, 5.2, 5.3
Screwdrivers, 2.7a
Screws, 2.5, 2.6, 2.8
Scriber, 2.2, 2.8
Shop towels, 5.2
Soft face hammer, 2.5, 2.6, 2.7a, 2.9
Soft jaws, 2.4, 2.5, 2.6
Spiders for chucks, 2.4
Spot facers, 2.8
Spotting drill, 2.6
Square (master or magnetic), 2.7b
Studs, 2.5, 2.6, 2.8
Surface finish comparison gages, 2.7b
Surface finish comparison plates, 2.3, 2.4, 2.5, 2.6, 2.8
Surface gage, 2.2, 2.7b, 2.8
Surface grinder, 2.7a, 2.7b
Surface plate, 3.1, 3.2, 5.3
Table capacity of approx. 12″ × 36″, 2.5, 2.6
Tape measure, 2.9
Taps, 2.8
Team conference area, 4.2
Telescoping gages, 2.4, 2.8, 5.3
Thread pitch gages, 2.3, 2.4
Thread ring and plug gages, 2.4
Thread ring gages, 2.3
3-jaw universal scroll chuck, 2.3, 2.4
Tool post, 2.3, 2.4
Tooling, 4.1
Turning tool blanks, 5.3
Vacuum cleaner, 5.1
Vernier dial or electronic caliper (6″), 2.3, 2.4, 2.5, 2.6, 2.7b, 2.8, 5.3
Vertical mill, 2.6
Washers, 2.5, 2.6, 2.8
Waste containers, 5.1, 6.1, 6.2
Waste handling devices, 6.1, 6.2
Wrenches, 2.3, 2.4, 2.7a, 2.9, 5.3
Writing tools, 4.2
X-bar and R charts, 3.2