



Curriculum Analysis Report

Manufacturing Skill Standards Council's
Certified Production Technician (CPT)
Curriculum

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Executive Summary

The Manufacturing Skill Standards Council and ACT recognize the benefits to relative stakeholders of “stacking” MSSC certification credentials upon ACT’s WorkKeys Assessments, specifically the National Career Readiness Certificate (NCRC), as the “foundation” for MSSC’s Certified Production Technician (CPT), Certified Logistics Associate (CLA), and Certified Logistics Technician (CLT) credentialing programs. The results of this project and review of its findings can help guide the selection of students into the program and encourage skill development for those applicants whose skills currently do not match the recommendations for entry.

The WorkKeys curriculum profiling procedure is designed to identify the skills and the skill levels needed to enter into and successfully complete a training program. When combined with the remaining components of the WorkKeys system, (i.e., the assessments, instructional support, and reporting), curriculum profiles provide educators with information regarding an individual’s readiness for training and provide individuals with the information they need to recognize the areas they may need to strengthen as they pursue their education and career goals.

The profile was conducted by ACT’s Industrial/Organizational Psychologist and profiler Cindy Hill, Ph.D. (Dr. Hill). The curriculum profiling procedure includes the following:

- A review of the curriculum materials including the textbook on Green Manufacturing and E-learning portal
- A skill analysis survey to 1) identify the WorkKeys skills required to accomplish each learning objective and 2) identify how the skills are used during the training program
- A skill level-setting virtual meeting with Subject Matter Experts (SMEs) identified by MSSC to determine the skill levels recommended for entry into and for successful completion of the five CPT individual certificate modules: Safety, Quality Practices & Measurement, Manufacturing Processes & Production, Maintenance Awareness, and Green Production.

On June 1, 2017, ACT introduced the Workplace Documents assessment. Previously, this assessment was called Reading for Information. The name of the assessment has changed, however, the criteria that define the levels for the Workplace Documents assessment has not changed. In other words, the criteria to be at Reading for Information levels 3, 4, 5, 6, and 7 are the same as the criteria for the Workplace Documents levels. As a result, the title of the assessment was changed throughout this report, but the levels set by the SMEs remained the same.

ACT also introduced the Applied Math assessment on June 1, 2017. Previously, this assessment was called Applied Mathematics. The name of the assessment has changed, however, the criteria that define Levels 3 and 4 for the Applied Math assessment have not changed. In other words, the criteria to be at Applied Math levels 3 and 4 are the same as the criteria for Applied Mathematics levels 3 and 4. Since the levels set for entry into CPT modules were either 3 or 4, the title of the assessment was changed throughout this report, but the the levels set by the SMEs

remained the same. However, there have been limited updates to levels 5, 6, and 7 of Applied Math. Since some of the modules did require levels 5 and 6, Dr. Hill reviewed the levels set by the SMEs and determined that the limited updates would not have changed the levels set by the SMEs.

The Graphic Literacy assessment was also introduced on June 1, 2107 and replaced the Locating Information assessment. Significant changes were made to the assessment and as a result the crosswalk is not as simple. Dr. Hill reviewed the raw data originally provided by the SMEs to determine if any changes to the skill levels was required. She determined that the levels remained the same. The results of her review are documented in this report.

Skill Level Recommendations for Entry into the CPT Individual Certificate Modules

WorkKeys Skill	Workplace Documents	Graphic Literacy	Applied Math
Skill Level Range	3-7	3-7	3-7
Safety	4	3	Not Required
Quality Practices & Measurement	4	4	4
Manufacturing Processes & Production	3	4	4
Maintenance Awareness	3	4	4
Green Production	4	4	3
Overall Entry Level	4	4	4

Skill Level Recommendations for Exit from the CPT Individual Certificate Modules

WorkKeys Skill	Workplace Documents	Graphic Literacy	Applied Math
Skill Level Range	3-7	3-7	3-7
Safety	4	3	Not Required
Quality Practices & Measurement	4	4	4
Manufacturing Processes & Production	5	6	5
Maintenance Awareness	5	6	6
Green Production	4	5	4
Overall Entry Level	5	5	5

Section 1

Curriculum Review

The first step in conducting the profile was to obtain background information on the program from the Manufacturing Skill Standards Council's (MSSC) representatives. This included obtaining the learning objectives of the program which indicate the parameters and expectations of the program and its requirements.

MSSC Courses were developed in strict adherence to the industry-recognized, nationally-validated standards upon which the Certified Production Technician (CPT) is based. These Courses, developed and delivered by Amatrol, have a proven track record of success in teaching the knowledge and skills identified in the national standards. The success rates for students taking MSSC Courses are nine points higher than those who do not (81% vs. 72%, respectively). MSSC Courses are highly interactive and utilize state-of-the-art, computer-based, simulation e-learning technologies and are delivered by MSSC-Authorized Instructors. MSSC does not authorize, review or endorse any other courses or curricula, and MSSC does not accept responsibility for the quality or effectiveness of courses other than MSSC Courses. MSSC does not require that individuals take MSSC Courses or any other MSSC-related courses before taking an MSSC Assessment.

MSSC delivers its CPT Courses through well-established training organizations. There are three types of Courses to meet various individual and training needs. These Courses are designed (a) to align with MSSC Standards and (b) to help individuals enhance their core knowledge and skills for production work from entry-level to front-line supervisory level.

These Courses are built upon MSSC's e-learning which includes modular courses for: Safety, Quality Practices & Measurement, Manufacturing Processes & Production, Maintenance Awareness, and Green Production. The online, computer-based simulation training covers the basic and technical skills while providing students and workers with the knowledge and skills needed to prepare them for an advanced, high-performance manufacturing environment.

The Courses can be delivered in three formats:

Modular Courses: 35-45 hours, 3-credit equivalent, one course for each of the five CPT modules. Can be given in a blended environment with classroom instruction by an instructor or in a fully online format with an online instructor. Recommended primarily for students and others studying in the framework of academic semesters or school years, dislocated workers or career changers.

Fast Track Courses: 15-18 hours for each module. Fully online with an online instructor. Recommended primarily for experienced incumbent workers or dislocated workers with manufacturing experience with limited time available for study. Not available for Green Production. Not available to high school students.

E-Learning: MSSC has partnered with Amatrol to develop online interactive learning units for the CPT training program. Currently there are 42 online units, each requiring about 2

hours to complete. (See the CPT e-Learning Video for an introduction to the online learning program.) These online units are carefully aligned with MSSC Standards to help prepare students with a knowledge and understanding of its four Critical Work Functions: Safety, Quality Practices & Measurement, Production & Processes, and Maintenance Awareness.

The specific features and benefits of these online units include:

- Increases computer skills
- Develops machine operation skills through computer-based simulations
- Increases access through online delivery accessible anywhere there is an internet connection
- Provides individualized instruction capability
- Enables greater training capacity through virtual delivery options

Section 2

Skill Analysis Survey

The Subject Matter Experts (SMEs) identified by MSSC completed a skill analysis survey to identify the WorkKeys skills required to accomplish each objective and to identify how the skills are used during the training program. Dr. Hill created a survey for each of the five individual certificate module curriculums. The SMEs were asked to identify which of the three WorkKeys skills are required for each learning objective within a unit, and they were asked to provide specific examples of how the skills are used. For example, if a graphic is used, they were asked to name the graphic and to briefly describe how it is used. If a formula is used, they were asked to provide the formula or to reference segment.

The SMEs participated in a WebEx session prior to receiving their survey. Rebekah Hutton, VP of Strategic Initiatives, welcomed and thanked the SMEs and explained the purpose of the study. Dr. Hill then explained that the study would consist of a survey and a second WebEx session to go over the results of the survey and to set entry and exit levels for each of the WorkKeys skills. Dr. Hill then reviewed the definitions for the WorkKeys Workplace Documents, Graphic Literacy, and Applied Math skills and provided examples from the training materials of each. (Descriptions of the WorkKeys skills can be found in Appendix A.) The SMEs were given the opportunity to ask questions throughout. The SMEs were also asked to choose the individual certificate module survey(s) they wanted to complete.

After the WebEx session, Dr. Hill sent each SME an e-mail containing links to the individual certificate module curriculums survey(s) they had previously chosen to complete, along with the learning objectives for their convenience. SMEs were encouraged to have the curriculum materials available for reference.

ACT combined the SMEs' input. During the second webcast, the results were used to guide the setting of the skill levels required for entry into and for successful completion of each program. A list of the Learning Objectives for each module can be found in Appendix B at the end of this report; an "X" in a skill column means that, according to the SMEs, the objective in that row requires that skill.

Section 3

Skill Level Setting

During November, 2015, a second WebEx session was held with the SMEs for each of the five modules to review the survey results and to set WorkKeys skill levels for entry into the programs. Dr. Hill presented detailed descriptions of the WorkKeys skill levels to the SMEs and showed them examples of problems or situations that individuals deal with at each level. For each WorkKeys skill, the SMEs decided the skill level that is necessary for entry to the training program and the skill level that is expected by program completion.

APPLIED MATH

WorkKeys Applied Math is the skill people use when they use mathematical reasoning and problem-solving techniques to solve work-related problems. Employees may use calculators and conversion tables to help with the problems, but they still need to use math skills to think them through.

Safety

The SMEs were unable to identify any learning objectives that required the Applied Math skill.

Quality Practices & Measurement

WorkKeys Applied Math is the skill people use when they use mathematical reasoning and problem-solving techniques to solve work-related problems. Employees may use calculators and conversion tables to help with the problems, but they still need to use math skills to think them through. The SMEs indicated that WorkKeys Applied Math is required for performing 20% of the learning objectives for this module.

Students use the Applied Math skill when they:

- Interpret blueprint drawings when shown an object. They may need to add or subtract lengths (e.g., 1.5 inches + 1.5 inches = 3 inches) and the numbers may be in fractions or decimals.
- Determine the dimension of an object on an undimensioned scaled drawing. They will use decimals and fractions.
- Determine if a part dimension is within tolerance by adding and subtracting numbers with decimals.
- Determine maximum and minimum material conditions as well as total lengths by adding or subtracting given data or by converting to percentages if tolerance is given in that form.

Students also use Applied Math skills when they learn basic measurement. Students learn to convert between U.S. customary units and S.I. metric units. They learn to multiply and divide fractions and decimals. When they obtain a caliper reading, they convert 2.00 cm to 20mm and they add the two readings together (e.g., 20mm + .869mm = 20.869mm).

Students also use math when they collect, interpret and aggregate data using a dial indicator. The formula for dimension measurement with a dial indicator is $D \text{ Indicator} = DR + MI$ (Action Dimension = Reference dimension + Measurement Indicator).

Students use math skills when they are introduced to statistical process control. They learn to calculate the mean and the range (i.e., $R = XL * XS$); they determine the width of each cell in a histogram when constructing one (e.g., $W = R/N$); and they calculate the Cpk measure to determine how well the process fits to the customer specifications. In control chart analysis, the student must find the mean and plot values in order to get the X-bar chart. The student manually records X-bar data, which requires them to measure, obtain an average, calculate the range, and then plot it onto the chart.

In evaluating the level of Applied Math skill necessary for the tasks of the job, the SMEs considered the types of mathematical operations (including single-step or multiple-step mathematical operations and conversions either within or between systems of measurement); how the information in the problem is presented (i.e., the information is presented in the order in which it is needed or it must be reordered); and whether all the information employees need for solving problems is provided or if they must derive some necessary information. The SMEs evaluated their work situation in comparison to WorkKeys Applied Math skill Levels 3 through 5. According to the SMEs, students need Level 4 skills to enter the training and Level 4 skills are sufficient to complete the training.

At Applied Math Level 4, tasks may present information out of order and may include extra, unnecessary information. One or two operations may be needed to solve the problem. A chart, diagram, or graph may be included. When employees use Level 4 Applied Math skills they can solve problems that require one or two operations. They may add, subtract, or multiply using positive or negative numbers, and they may divide positive numbers. They can figure out an average or mean of a set of numbers using whole numbers and decimals. They can figure out simple ratios, simple proportions, or rates. At Level 4 employees can add commonly known fractions, decimals, or percentages and add or subtract fractions that share a common denominator. They can multiply a mixed number by a whole number or decimal and they can put the information in the right order before they perform calculations.

Students are expected to apply their math skills to specific situations during the training program, so they need to begin the program already knowing how to add commonly known fractions, decimals, and percentages, to add fractions that share a common denominator, and to put information in the right order before they perform calculations. They will use Applied Math Level 4 skills when they add or subtract lengths (e.g., 1.5 inches + 1.5 inches = 3 inches) and the numbers may be in fractions or decimals, determine the dimension of an object on an undimensioned scaled drawing, determine if part dimension is within tolerance by adding and subtracting numbers with decimals, and determine maximum and minimum material conditions as well as total lengths by adding or subtracting given data or converting to percentages if tolerance is given in that form.

The ability to look up a formula and to change from one unit to another in a single step, either within a system of measurement or between systems of measurement, is a Level 5 Applied Math skill. Being able to apply basic statistical concepts, such as measures of

central tendency (e.g., mode, median, and weighted mean), is a Level 7 Applied Math skill. However, students are provided with both the formulas that they are to use and specific instruction regarding when and how to use those formulas. As a result, the SMEs decided that students with Level 4 skills could learn how to perform unit conversions, how to use the formula for dimension measurement with a dial indicator, and how to calculate the mean and the range when developing control charts. In addition, students are not required to learn or perform any of the other Level 5 or 7 skills.

Manufacturing Processes & Production

WorkKeys Applied Math is the skill people use when they use mathematical reasoning and problem-solving techniques to solve work-related problems. Employees may use calculators and conversion tables to help with the problems, but they still need to use math skills to think them through. The SMEs indicated that the WorkKeys Applied Math is required for performing 8% of the learning objectives for this module.

Students learn the Applied Math skill when they learn to calculate:

- Quantity discrepancies by reporting variances in shipments.
- Productivity such as down time and production per hour.
- Torque, mechanical advantage of a lever and moment.
- The coefficient of friction given application data and the mechanical advantage of an inclined plane.
- Machine availability, product cost, and productivity.

In evaluating the level of Applied Math skill necessary for the tasks of the job, the SMEs considered the types of mathematical operations (including single-step or multiple-step mathematical operations and conversions either within or between systems of measurement); how the information in the problem is presented (i.e., the information is presented in the order in which it is needed or it must be reordered); and whether all the information employees need for solving problems is provided or if they must derive some necessary information. The SMEs evaluated their work situation in comparison to WorkKeys Applied Math skill Levels 3 through 7. According to the SMEs, students need Level 4 skills to enter the training and may demonstrate Level 5 skills when they exit the training.

At Applied Math Level 4, tasks may present information out of order and may include extra, unnecessary information. One or two operations may be needed to solve the problem. A chart, diagram, or graph may be included. When employees use Level 4 Applied Math skills they can solve problems that require one or two operations. They may add, subtract, or multiply using positive or negative numbers, and they may divide positive numbers. They can figure out an average or mean of a set of numbers using whole numbers and decimals. They can figure out simple ratios, simple proportions, or rates. At Level 4 employees can add commonly known fractions, decimals, or percentages and add or subtract fractions that share a common denominator. They can multiply a mixed number by a whole

number or decimal and they can put the information in the right order before they perform calculations.

If a student has Level 4 Applied Math skills when they enter the program, they are able to learn how to apply a formula to:

- Determine the hours worked: $T = (H_s \times D) \times (H_B \times D)$.
- Calculate machine availability: $MA = T_A - T_{SD} - T_{USD}$
- Estimate product cost: $C_P = \frac{C_{mat} + C_L + C_O}{N}$
- Calculate productivity: $P = \frac{N}{T}$
- Calculate mechanical advantage: $MA = \frac{W}{F} = \frac{L}{H}$

When students learn to calculate force of friction and the coefficient of friction, they apply the formulas, substitute values and manipulate the formulas:

$$F_f = \mu \times F_N \text{ and } \mu = \frac{F_f}{F_N}$$

By the end of the program, students should have Level 5 Applied Math skills At Applied Math Level 5, the information may not be presented in logical order; the item may contain extraneous information; it may contain a chart, graph, or diagram; and the mathematical set-up may be complicated. In solving the problem, the employee may need to perform multiple operations. When employees use Level 5 Applied Math skills they must decide what information, calculations, or unit conversions to use to find the answer to a problem. As part of a multiple step problem, the employee may have to find one value and use it to find another value that answers the question. They can add and subtract fractions with unlike denominators. Employees can convert units within or between systems of measurement where the formula is provided such as converting from ounces to pounds or from centimeters to inches. They can solve problems that require mathematical operations using mixed units. They can identify the best deal by doing one- and two-step calculations and then comparing the results to determine the solution that meets the stated conditions. At Level 5 employees can calculate perimeters, circumference, and areas of basic shapes like rectangles and circles. They can calculate a given percentage of a given number and then use that percentage to determine the solution. They can identify where a mistake occurred in a calculation.

Maintenance Awareness

WorkKeys Applied Math is the skill people use when they use mathematical reasoning and problem-solving techniques to solve work-related problems. Employees may use calculators and conversion tables to help with the problems, but they still need to use math skills to think them through. The SMEs indicated that the WorkKeys Applied Math is required for performing 7% of the learning objectives for this module.

Students use Ohm's Law to describe voltage, know how to use a voltmeter to measure voltage, and know the voltage characteristics in series and parallel circuits. Ohm's law states that the current through a conductor between two points is directly proportional to the

voltage across the two points. Introducing the constant of proportionality, the resistance, one arrives at the usual mathematical equation that describes this relationship:

$$I = \frac{V}{R},$$

where I is the current through the conductor in units of amperes, V is the voltage measured across the conductor in units of volts, and R is the resistance of the conductor in units of ohms. More specifically, Ohm's law states that the R in this relation is constant, independent of the current.

The students also use Ohm's Law to explain the characteristics of resistance (Resistance x Current = voltage). They need to calculate series resistance given each load's resistance, and calculate voltage, current, and resistance in a series circuit. Students need to verify Kirchoff's Voltage Law for a series circuit and calculate the total power used by a circuit. They use formulas, such as $E(\text{Total}) = E_1 + E_2 + E_3 \dots \text{etc.}$, and Watts Law (Power) formula $P = I \times E$, and variations on the Power Formula such as substituting $I \times R$ for E into the Power formula: $P = I \times I \times R$ and $P = I^2 \times R$. Students locate these numbers on schematics in order to set-up the formulas. Students will calculate and measure the mechanical advantage of a gear drive using the formulas

$$MA = \frac{T_{driven}}{T_{driver}} \quad MA = \frac{D_{driven}}{D_{driver}}$$

In order to calculate pulley ratio, students utilize formulas to calculate speed, torque, radius, circumference, and diameter. They also use formulas to calculate the shaft speed and torque of a belt drive system and the shaft speed and torque of a chain drive system. When students are learning about the function of NOT logic and its application, they may be exposed to Boolean functions and digital logic. They may also need to design a time-driven traffic light circuit that will require this math skill.

In evaluating the level of Applied Math skill necessary for the tasks of the job, the SMEs considered the types of mathematical operations (including single-step or multiple-step mathematical operations and conversions either within or between systems of measurement); how the information in the problem is presented (i.e., the information is presented in the order in which it is needed or it must be reordered); and whether all the information employees need for solving problems is provided or if they must derive some necessary information. The SMEs evaluated their work situation in comparison to WorkKeys Applied Math skill Levels 3 through 7. According to the SMEs, students need Level 4 skills to enter the training and will probably have Level 6 skills when they exit the training.

At Applied Math Level 4, tasks may present information out of order and may include extra, unnecessary information. One or two operations may be needed to solve the problem. A chart, diagram, or graph may be included. When employees use Level 4 Applied Math skills they can solve problems that require one or two operations. They may add, subtract, or multiply using positive or negative numbers, and they may divide positive numbers. They can figure out an average or mean of a set of numbers using whole numbers and

decimals. They can figure out simple ratios, simple proportions, or rates. At Level 4 employees can add commonly known fractions, decimals, or percentages and add or subtract fractions that share a common denominator. They can multiply a mixed number by a whole number or decimal and they can put the information in the right order before they perform calculations.

Students are expected to apply their math skills to specific situations during the training so they already need to know how to solve problems when the information is provided out of order and there is extra unnecessary information. They are presented with schematics and must identify the information they need. The concept of proportion and rates is introduced with Ohm's Law. The students work with many fractions and mixed numbers. Students are also introduced to and taught how to use formulas for Kirchoff's Voltage Law and Watts Law.

By the time students have completed the training, they should have Level 6 Applied Math skills. At Applied Math Level 6, tasks may require considerable translation from verbal form to mathematical expression. They generally require considerable setup and involve multiple-step calculations. When employees use Level 6 Applied Math skills they can use fractions with unlike denominators and calculate reverse percentages. They can convert units within or between systems of measurement where multiple-step conversions are required and the formulas are provided such as converting from kilometers to meters to feet. They can identify why a mistake occurred in a solution. Employees can find the best deal and use the result for another calculation. They can find the area of basic shapes (rectangles and circles) when it may be necessary to rearrange the formula, convert units of measurement in the calculations, or use the result in further calculations. At Level 6 employees can find the volume of rectangular solids. They can calculate rates, production rates, and rate by time. They can identify the correct equation for solving a problem.

Students learn how to determine which formula or formulas to use and how to transpose them depending on what information they have available. For example, in circuit analysis, three equivalent expressions of Ohm's law are used interchangeably.

$$I = \frac{V}{R} \quad \text{or} \quad V = IR \quad \text{or} \quad R = \frac{V}{I}.$$

Students need to locate these numbers on schematics and then set-up the problem. They may need to use more than one formula to find the answer they need. Level 6 math skills are required to find the area of basic shapes by rearranging a formula, converting units of measurement, and using the results for further calculations such as when they are calculating pulley ratio, the students utilize formulas to calculate speed, torque, radius, circumference, and diameter. They will need to be able to understand variations on the Power Formula (e.g., $I \times R$ for E , $P = I \times I \times R$ and $P = I^2 \times R$). The amount of set-up and translation required becomes much more difficult as the student progresses through the training. By the end of the training, they are expected to perform all of these tasks without any assistance.

Green Production

WorkKeys Applied Math is the skill people use when they use mathematical reasoning and problem-solving techniques to solve work-related problems. Employees may use calculators

and conversion tables to help with the problems, but they still need to use math skills to think them through. The SMEs indicated that the WorkKeys Applied Math is required for performing 11% of the learning objectives for this module.

Students learn to gather data and analyze it in order to determine if there are problems and to recommend improvement. They are often required to use math when working with this data. For example, students will:

- Use indicators, gauges and computers to inspect and analyze results.
- Identify and evaluate opportunities. This includes increasing energy-efficiency and reducing energy-related carbon emissions.
- Take energy-efficient measures on the production line.
- Read and interpret instruments to ensure required controls.
- Use environmental controls/levels required for production with advanced materials.

In evaluating the level of Applied Math skill necessary for the tasks of the job, the SMEs considered the types of mathematical operations (including single-step or multiple-step mathematical operations and conversions either within or between systems of measurement); how the information in the problem is presented (i.e., the information is presented in the order in which it is needed or it must be reordered); and whether all the information employees need for solving problems is provided or if they must derive some necessary information. The SMEs evaluated their work situation in comparison to WorkKeys Applied Math skill Levels 3 through 5. According to the SMEs, students need Level 3 skills to enter the training and will probably have Level 4 skills when they exit the training.

At Applied Math Level 3, problems can easily be translated from a word problem to a math equation requiring a single type of math operation. All the needed information is presented in a logical order and there is no extra information given. When employees use Level 3 Applied Math skills they can solve problems that require a single type of mathematical operation. They add or subtract either positive or negative numbers; they multiply or divide using only positive numbers. At Level 3, they can convert a familiar fraction to a decimal and convert from a decimal to a common fraction; or convert between decimals to percentages. Employees can convert between familiar units of money and time.

At Applied Math Level 4, tasks may present information out of order and may include extra, unnecessary information. One or two operations may be needed to solve the problem. A chart, diagram, or graph may be included. When employees use Level 4 Applied Math skills they can solve problems that require one or two operations. They may add, subtract, or multiply using positive or negative numbers, and they may divide positive numbers. They can figure out an average or mean of a set of numbers using whole numbers and decimals. They can figure out simple ratios, simple proportions, or rates. At Level 4 employees can add commonly known fractions, decimals, or percentages and add or subtract fractions that share a common denominator. They can multiply a mixed number by a whole number or decimal and they can put the information in the right order before they perform calculations.

Students will be taught how to find information on charts and tables and determine if the reading they have is within the allowed range by subtracting or adding numbers. They may also need to average readings across a day or shift. If there are set targets or objectives for an ongoing program, they may need to compare readings to determine if it is within range or if they need to take corrective action. These problems may involve one or two operations and there will usually be extra, unnecessary information. They often have to find information on simple charts, diagrams, or graphs in order to set-up the problem.

GRAPHIC LITERACY

The WorkKeys Graphic Literacy skill is the skill people use when they work with workplace graphics such as tables, graphs, charts, digital dashboards, flow charts, timelines, forms, maps, and blueprints. Employees use this skill when they find, summarize, compare, and analyze information to make decisions using workplace graphics to solve work-related problems.

Safety

The SMEs indicated that the WorkKeys Graphic Literacy skill is required for entry into and successful completion of the training program. The Graphic Literacy skill is used to accomplish 10% of the learning objectives for this module.

According to the SMEs, students need the Graphic Literacy skill when they do the following:

- Identify the major sub-industries within manufacturing.
- Identify major concentrations in frontline manufacturing.
- Identify systems used in high-performance manufacturers to produce quality goods at the lowest possible cost.
- Describe a six-step team problem solving process.
- Review a Training Record Form.
- Navigate through the 7 types of personal protective equipment.
- Identify part of a fire extinguisher on a diagram.
- Identify specific fields on a tag (for lockout/tagout).
- Identify three types of safe work permits, such as Hot Work and Confined Space Entry Permit.
- Locate the type of hazardous material on a label.
- Locate information on labels using the National Fire Protection Association Hazardous Material Identification System.

- Apply the DOT Hazardous Material Shipping System – proper name of material, United Nations identification Number, packaging and Quantity Restrictions and Hazard Classification on label.
- Interpret NPCA Hazardous Material identification System – table that shows substance identity and bars indicating whether it is a health, flammability, or physical hazard and type of personal protection needed.
- Locate information on a material safety data sheet (MSDS), which includes a title block, identity, and 8 sections.
- Use a diagram showing how lubricant can be recycled using gravity separation, straining, or filtering.
- Perform electrical and pneumatic lockout/tagout.
- Use diagrams of different types of powered industrial trucks.
- Use a diagram showing components of a forklift truck and nameplate.

To determine the level of Graphic Literacy skill needed to accomplish the learning objectives, the SMEs considered the difficulty of the graphics and how hard it is for individuals to find the information they need on the graphic and then to make use of it. The SMEs compared the requirements of the training program to WorkKeys Graphic Literacy skill Levels 3 through 5. The SMEs agreed that Level 3 skills are required for entry into and for successful completion of the training.

At Graphic Literacy Level 3, workplace graphics are common and of simple or low moderate difficulty. Characteristics of simple graphics include a limited amount of data (i.e., less than twenty data points/fields); one level of data; one or two variables; and one or two axes (such as an x and/or y axis), if there are axes. Characteristics of low moderate graphics include a moderate amount of data; more than one level of data, but no nesting; several variables; one or two axes if there are axes; and if two simple graphics are required to solve the problem, they should be considered a low moderate graphic. At Graphic Literacy Level 3, employees use one simple or low moderate graphic at a time to locate and find information and identify the next or missing step in a process.

The training material is often presented in a simple table format. For example, the students are presented with the major sub-industries within manufacturing, major concentrations in frontline manufacturing, systems used in high-performance manufacturers to produce quality goods at the lowest possible cost, and the six-step team problem solving process using simple tables. There is only one simple graphic used to present information to them.

The students also receive several forms and need to find each piece of information or area where information would be located, as the e-learning or instructor directs them to it and provides an explanation. Some of the forms include a training record form, a material safety data sheet (MSDS), and safe work permits, such as Hot Work and Confined Space Entry Permits.

The student also needs to find information that is pointed out to them on a diagram. For example, the student is presented with diagrams showing how lubricant can be recycled using gravity separation, straining and filtering. Students need to be able to identify the differences. This is simple because the different areas are labeled. Students are also presented with diagrams of a fire extinguisher, different types of powered industrial trucks, and components of a forklift truck and nameplate. The diagrams are labeled so the student can easily find what they are looking for.

Graphic Literacy skill Level 3 is also used when students are shown how to identify specific fields on a tag (e.g., lockout/tagout) and the type of hazardous material identified on a label. Students are shown how to locate information on labels that use the National Fire Protection Association Hazardous Material Identification System and the NPCA Hazardous Material identification System. For example, when students are taught the NPCA Hazardous Material identification System, they are shown a table that shows substance identity, with bars indicating whether the substance is a health, flammability, or physical hazard, in addition to the type of personal protection needed. While the table is explained, the student locates each area as it is identified by the e-learning system or the instructor.

Quality Practices & Measurement

The SMEs indicated that the WorkKeys Graphic Literacy skill is required for entry into and for successful completion of the training program. The Graphic Literacy skill is used to accomplish 18% of the learning objectives for this module.

The first three units of the training program cover blueprint reading, which includes multi-view drawings, assembly drawings and fasteners, and geometric dimensioning and tolerancing. Students learn how to identify and describe the functions of different parts of the drawing and to interpret drawings. The types of blueprints that students are expected to use build upon each other and are progressively more difficult. The drawings usually include a legend, and students must determine the correct symbol based on given data.

Students also learn to use a machinist's rule. A machinist's rule has graduations, and students line up a part to locate its length, width, and diameter. Students also learn to calibrate and use a dial caliper. On this tool, a dial magnifies the graduations on the rule, and students learn how to locate the level of graduations. They also learn to use a micrometer to obtain measurements and to use a dial indicator to measure a dimension (i.e., movement of indicator needle on a dial). This data is usually collected and displayed using data acquisition software that students also need to learn how to use.

Students are also required to describe the PDCA cycle and are shown a PDCA graphic (plan-do-check-act). A PDCA graphic is a very basic graphic with four steps. Students learn how to use a sampling plan to determine how many samples to take and how often to take them. When students conduct product inspections, they take measurements and record them on a form or in the computer system.

Students are introduced to statistical process control and control charts. When learning about central tendency, Bell Curve and Gaussian Curve diagrams are used. Students create a histogram giving a set of data. This requires them to insert information, to examine the histogram, and to make decisions based on the information in the graphic. They determine if a process is in or out of control and, if it is out of control, they determine if the cause is common or special. They also must be able to describe the customer parameters and decide if they can make the product based on the information.

Students learn how to use Control Charts (e.g., histograms, time chart, X-bar and R chart) that are used to monitor processes and to spot trends, patterns, and large variations. They also learn to construct a Cause and Effect Diagram (i.e., C&E) and a Pareto Diagram (i.e., bar graph and cumulative frequency plot) and to complete a Corrective Action Report.

Students learn the critical steps for reporting and documenting the process of preventive and corrective actions.

To determine the level of Graphic Literacy skill needed to accomplish the learning objectives, the SMEs considered the difficulty of the graphics and how hard it is for individuals to find the information they need and to make use of it. The SMEs compared the requirements of the training program to WorkKeys Graphic Literacy skill Levels 3 through 5. The SMEs agreed that Level 4 skills are required for entry into and for successful completion of the training.

At Graphic Literacy Level 4, workplace graphics are common and of low to high moderate difficulty. Characteristics of low moderate graphics include a moderate amount of data; more than one level of data, but no nesting; several variables; one or two axes, if there are axes; and if two simple graphics are required to solve the problem, they should be considered a low moderate graphic. At Graphic Literacy Level 4, employees can use one or two low moderate graphics at a time to locate information in a graphic using information found in another graphic; compare two or more pieces of information; identify a trend/pattern/relationship; make an inference or decision; and identify the graphic that accurately represents the data. High moderate graphics may be less common at Graphic Literacy Level 4 and have characteristics which include a moderate amount of data; more than one level of data and it may be nested; many variables such as types of wood, drill speeds, hole diameter, and type of bit; one or two axes (such as an x and/or y axis), if there are axes; and if a low moderate graphic and a simple graphic are required to solve the problem, they should be considered a high moderate graphic. At

Level 4, employees can use one high moderate graphic to locate and find information and identify the next or missing step in a process.

Level 4 Graphic Literacy skills are required when students read blueprints. They must identify the different parts of a drawing, and the drawings usually include a legend. Students also need to determine the correct symbol based on given data.

When students learn to use a machinist's rule, dial caliper, and a micrometer, they need Graphic Literacy Level 4 skills. They must be able to read the graduations and enter the measurements into data acquisition software. Sampling plans are usually straightforward tables, but students may need to find several pieces of information, such as how many samples to take and how often to take them. When they conduct product inspections, they need to be able to take measurements and record them on a form or in the computer system.

Students use Level 4 skills when they learn to construct a histogram. The data will often be presented in a table, and the students need to insert it appropriately. Then they compare the results to customer parameters. When students learn to monitor a process and look for trends, patterns and large variations, they use Level 4 skills to compare data from one graphic to data in another graphic. The forms they complete to report and document the process of preventive and corrective actions usually requires that they also summarize information from other graphics.

Manufacturing Processes & Production

The SMEs indicated that the WorkKeys Graphic Literacy skill is required for entry into and to complete the training program. The Graphic Literacy skill is used to accomplish 8% of the learning objectives for this module.

Students use the Graphic Literacy skill when they learn how to:

- Use graphs to compare what is forecast with production results.
- Review forms and tables to identify product specifications.
- Review Standard Operating Procedures and Safety Job Sheets.
- Use a spring scale to measure the weight and force of an object.
- Use a table showing the common coefficients of friction.
- Use diagrams to explain the importance of an inclined plane.
- Use diagrams to demonstrate rolling friction.
- Use diagrams and graphics to show how to connect and operate a slider crank, double rocker, crank rocker, cam and cam follower.
- Use a table to determine sheet metal gauge.

- Use a ruler to select the size of a common metal stock shape.
- Select stock size and type given a part drawing.
- Determine the size of a drill based on a caliper reading.
- Change the spindle speeds on a floor drill press.
- Use a drill chart to assist in selecting the correct drill size.
- Fill out "break-down" documents and Repair "Work Orders."
- Set up machines. This requires measurement, reading prints for set points, and responding to a machine malfunction. Students learn to read prints and schematics, measuring parts to determine defect, and possibly reading error codes and using code tables.
- Use Manufacturing layouts (prints) to identify bottlenecks and suggest improvements.
- Students use graphic literacy skills when they learn how to perform layout work. Layout work is the process of transferring data, such as hole locations and other features, from the technical drawing to the part's surface. They learn how to use a machinist's rule and a combination square. Students also use calendars, Bill of Materials, master production and purchasing schedules, manufacturing work order, materials requisition form, and discrepant materials form.

When students learn about production control, they use their graphic literacy skills to complete a process form called Process Failure Mode and Effect Analysis and a design form called Design Failure Mode and Effect Analysis. They learn to interpret shipping instructions, including a pick list and box manufacturer's certificates, to identify the maximum weight and size the box should hold, bursting strength, and edge crush results. Students also learn how to locate information on shipping documents such as packing slip, shipping manifests, pallet manifests, bills of lading, and inbound and outbound shipping documents. When learning about process and design failure, they learn to complete a process form called Process Failure Mode and Effect Analysis and a design form called Design Failure Mode and Effect Analysis.

To determine the level of Graphic Literacy skill needed to accomplish the learning objectives, the SMEs considered the difficulty of the graphics and how hard it is for individuals to find the information they need and make use of it. The SMEs compared the requirements of the training program to WorkKeys Graphic Literacy skill Levels 3 through 6. The SMEs agreed that Level 4 skills are required for entry into and Level 6 skills should be achieved by the time the students exit from the training.

At Graphic Literacy Level 4, workplace graphics are common and of low to high moderate difficulty. Characteristics of low moderate graphics include a moderate

amount of data; more than one level of data, but no nesting; several variables; one or two axes, if there are axes; and if two simple graphics are required to solve the problem, they should be considered a low moderate graphic. At Graphic Literacy Level 4, employees can use one or two low moderate graphics at a time to locate information in a graphic using information found in another graphic; compare two or more pieces of information; identify a trend/pattern/relationship; make an inference or decision; and identify the graphic that accurately represents the data. High moderate graphics may be less common at Graphic Literacy Level 4 and have characteristics which include a moderate amount of data; more than one level of data and it may be nested; many variables such as types of wood, drill speeds, hole diameter, and type of bit; one or two axes (such as an x and/or y axis), if there are axes; and if a low moderate graphic and a simple graphic are required to solve the problem, they should be considered a high moderate graphic. At Level 4, employees can use one high moderate graphic to locate and find information and identify the next or missing step in a process.

Students use Graphic Literacy Level 4 skills when they use handling forms, facility maps, and storage guidelines to figure out where to put a product that is highly flammable and/or corrosive. It is important that they are very aware of allergens in food manufacturing so they will need to read labels and know what can and cannot mix, and what needs to be stored in a vertical position. For example, if there is a pallet of material that was soy mixed with wheat in bottom section, they could put wheat or soy above it, but they should not add something completely different. They need to pay attention to the load limit for a shelf and to use a location map of warehouse to decide what to put where. These documents, maps, and labels are straightforward, but employees may need to work with one or two of them at a time and usually need to find several pieces of information.

The training introduces students to scatter charts and how to use them to determine if a product is headed out of spec. For example, 25 parts were rejected during the last shift and it is already up to 30 for the next shift. They learn how to analyze the data coming in from various areas, such as measurements and test results from the quality department, data from the machines themselves and, any work orders, in order to determine what action to take.

Students use Level 4 skills when they set up machines. Students learn to read prints and schematics, measure parts to determine defect, and possibly read error codes and use code tables to determine why a machine is malfunctioning. Depending on the machine, these materials can range from straightforward to very complicated.

By the end of training, students should have achieved Level 6 Graphic Literacy skills. At Graphic Literacy Level 6, workplace graphics may be less common and of high moderate or difficult complexity. High moderate graphics may be less common and characteristics include a moderate amount of data; more than one level of data and it may be nested; many variables; one or two axes, if there are axes; and if a low moderate graphic and a simple graphic are required to solve the problem, they should be

considered a high moderate graphic. At Graphic Literacy Level 6, employees can use a high moderate graphic to compare two or more pieces of information; interpret a trend/pattern/relationship; make a reasonable inference or decision based on one graphic after finding information in another graphic; justify a decision or inference based on information; identify the most effective graphic for the task; and justify the most effective graphic for the task. Difficult graphics are likely to be less common or a composite of graphics. At Graphic Literacy Level 6, data presented is dense; more than one level of data and nesting is likely; there are many variables; there will be three or more axes, if there are axes; and if a low moderate graphic and a high moderate graphic are required to solve the problem, they should be considered a difficult graphic. At Level 6, employees can use one difficult graphic to locate information in a graphic using information found in another graphic; compare two or more pieces of information; identify a trend/pattern/relationship; make an inference or decision; and identify the graphic that accurately represents the data.

Students develop Graphic Literacy Level 6 skills as they learn how to perform layout work. The technical drawings will be simple at first, but will gradually become very complicated, with large amounts of information and challenging formats. When students learn about production planning, they use Level 6 skills to apply information from calendars, Bills of Material, master production and purchasing schedules, manufacturing work orders, materials requisition forms, and discrepant materials forms. It is critical that they are able to make connections between the graphics to identify possible problems and they need to be able to make decisions when problems arise.

When students are learning about production control, they use Level 6 skills to evaluate manufacturing processes by reviewing manufacturing layouts (prints) to identify bottlenecks, gathering data from many different sources and completing a Process Failure Mode and Effect Analysis and a Design Failure Mode and Effect Analysis. Based on the results of their data gathering, they need to be able to evaluate the results and draw conclusions.

Maintenance Awareness

The SMEs indicated that the WorkKeys Graphic Literacy skill is required for entry into and for completion of the training program. The Graphic Literacy skill is used to accomplish 56% of the learning objectives for this module.

Students will use the Graphic Literacy skill when they learn to:

- Identify the proper material to use for different types of welding applications using charts.
- Use a circuit tester to check a wall outlet for electricity.
- Connect and operate a circuit using three types of manual switches.
- Connect and operate an electrical circuit with a resistor, a buzzer, a solenoid, and a motor.

- Construct a design using electrical wiring diagrams and/or schematics.
- Use an analog voltmeter or a digital multimeter to measure the voltage at a point referenced to ground.
- Use a digital multimeter to measure the voltage at a point referenced to ground, voltage drops in series and parallel circuits, the electrical current, the current in a series and parallel circuits, the resistance of a component, the resistance in series and parallel circuits, and to test the continuity of wires using a DMM.

Students use charts to identify proper materials and sizing, and they use schematics, pictorials and graphs to explain the operation of equipment. This includes learning about electrical power. Students use charts, graphics, symbology and pictorials to explain proper equipment usage and assembly of pneumatic and hydraulic power systems. They use these graphics to explain and/or identify proper usage of lubrication concepts. Schematics and drawings are used when they install and adjust a pillow block antifriction bearing and shaft or a flexible jaw coupling, connect and operate a gear drive system, verify alignment of a fractional HP V-belt drive with a finished bore, and use a belt tension tester to measure belt tension, determine the belt deflection force for a given application, and install chains and adjust for sag.

Learning about machine control concepts and machine automation requires students to learn about different functions and logic control circuits. Schematics and ladder diagrams are used throughout the modules. The students also learn to use the National Electric Code book.

To determine the level of Graphic Literacy skill needed to accomplish the learning objectives, the SMEs considered the difficulty of the graphics and how hard it is for individuals to find the information they need and to make use of it. The SMEs compared the requirements of the training program to WorkKeys Graphic Literacy skill Levels 3 through 6. The SMEs agreed that Level 4 skills are required for entry into training and Level 6 skills should be achieved by the time the students exit from the training.

At Graphic Literacy Level 4, workplace graphics are common and of low to high moderate difficulty. Characteristics of low moderate graphics include a moderate amount of data; more than one level of data, but no nesting; several variables; one or two axes, if there are axes; and if two simple graphics are required to solve the problem, they should be considered a low moderate graphic. At Graphic Literacy Level 4, employees can use one or two low moderate graphics at a time to locate information in a graphic using information found in another graphic; compare two or more pieces of information; identify a trend/pattern/relationship; make an inference or decision; and identify the graphic that accurately represents the data. High moderate graphics may be less common at Graphic Literacy Level 4 and have characteristics which include a moderate amount of data; more than one level of data and it may be nested; many variables such as types of wood, drill speeds, hole diameter, and type of bit; one or two axes (such as an x and/or y axis), if there are axes; and if a low moderate graphic and a simple graphic are

required to solve the problem, they should be considered a high moderate graphic. At Level 4, employees can use one high moderate graphic to locate and find information and identify the next or missing step in a process.

The Level 4 graphics the students use when identifying the proper material to use for different types of welding applications are straightforward. The students need to find several pieces of information. The digital multimeters, gauges, and the instrument panels on power supplies they will use are also straightforward.

The training begins by showing students schematics and pictorials for basic electrical circuits. The students are shown the electrical parameters such as resistance, voltage and current. They are taught the different schematic symbols, such as normally open and normally closed contacts, switches, and output devices. The schematics become more difficult as the student progresses. For example, they will need to work with pneumatic, circuit branches, 3-Position, 4-way DCV, hydraulic motors, but the schematics will always build on what the students have already learned.

By the end of training, students should have achieved Level 6 Graphic Literacy skills. At Graphic Literacy Level 6, workplace graphics may be less common and of high moderate or difficult complexity. High moderate graphics may be less common and characteristics include a moderate amount of data; more than one level of data and it may be nested; many variables; one or two axes, if there are axes; and if a low moderate graphic and a simple graphic are required to solve the problem, they should be considered a high moderate graphic. At Graphic Literacy Level 6, employees can use a high moderate graphic to compare two or more pieces of information; interpret a trend/pattern/relationship; make a reasonable inference or decision based on one graphic after finding information in another graphic; justify a decision or inference based on information; identify the most effective graphic for the task; and justify the most effective graphic for the task. Difficult graphics are likely to be less common or a composite of graphics. At Graphic Literacy Level 6, data presented is dense; more than one level of data and nesting is likely; there are many variables; there will be three or more axes, if there are axes; and if a low moderate graphic and a high moderate graphic are required to solve the problem, they should be considered a difficult graphic. At Level 6, employees can use one difficult graphic to locate information in a graphic using information found in another graphic; compare two or more pieces of information; identify a trend/pattern/relationship; make an inference or decision; and identify the graphic that accurately represents the data.

Students also work with multiple detailed graphics such as wiring diagrams and wire sizing charts. They need to consider the amperage and the environment to make decisions regarding how much heat it can handle and the insulation rating. They also refer to the National Electric Code. When they are sizing circuits, they use the code book to determine what the allowable overage or underage is (e.g., 27 amps use 20 amp circuit breaker or 30 amp). It is critical that they understand the connections between the graphics and apply the information to specific situations.

Green Production

The SMEs indicated that the WorkKeys Graphic Literacy skill is required for entry into and for completion of the training program. The Graphic Literacy skill is used to accomplish 47% of the learning objectives for this module.

According to the SMEs, students need the Graphic Literacy skill to do the following:

- Identify the benefits of environmental assurance programs for workers, companies, and society, using the Key Benefits of Green Manufacturing bar chart, which is color coded and ordered from least to most.
- Discuss why environmental training for workers should be documented and review examples of the types of documentation the company needs.
- Review and understand environmental policies and procedures that are communicated and posted, such as OSHA regulations and Material Safety Data Sheets (MSDS), for the types of chemicals employees may be working with in the plant.
- Report environmental violations.
- Access environmental assurance materials in the plant.
- Record amounts of calibration reading for gauges
- Record amounts of oil and water mixtures including how much was skimmed off and how much is left in drum to record on hazardous waste manifest.
- Conduct a basic investigation using Root Cause Analysis checklist and Incident Investigation Form to document findings that are timely and correct.
- Identify, report, and document conditions that present a threat to the environment and possible environmental hazards in the work area using charts, such as the flow chart for electrocution.
- Monitor environmental aspects at each stage of production, use indicators and gauges, and document the results. In addition, they may use the Waste Stream # table that shows the specific waste stream numbers related to each aspect of production.
- Monitor the consumption of energy hidden in lean waste using a table that lists the waste type and energy use.
- Monitor the use and saving of resources and harmful agents to reduce impact on the environment, and monitor and evaluate energy use, energy waste and emissions. The List of Environmental Concerns and Linkages to Manufacturing Processes table is provided for easy reference.

- Use designated equipment to monitor, measure and handle advanced materials including the use of visual controls to track results (e.g., analog gauge that is color coded to show energy use).
- Sort used or rejected materials to determine which should be recycled and which can be reused or repurposed in the company.
- Place waste in proper recycling containers.
- Help to coordinate recycling activities with contractors.

To determine the level of Graphic Literacy skill needed to accomplish the learning objectives, the SMEs considered the difficulty of the graphics and how hard it is for individuals to find the information they need and to make use of it. The SMEs compared the requirements of the training program to WorkKeys Graphic Literacy skill Levels 3 through 6. The SMEs agreed that Level 4 skills are required for entry into the training and students should exit from the training with Level 5 skills.

At Graphic Literacy Level 4, workplace graphics are common and of low to high moderate difficulty. Characteristics of low moderate graphics include a moderate amount of data; more than one level of data, but no nesting; several variables; one or two axes, if there are axes; and if two simple graphics are required to solve the problem, they should be considered a low moderate graphic. At Graphic Literacy Level 4, employees can use one or two low moderate graphics at a time to locate information in a graphic using information found in another graphic; compare two or more pieces of information; identify a trend/pattern/relationship; make an inference or decision; and identify the graphic that accurately represents the data. High moderate graphics may be less common at Graphic Literacy Level 4 and have characteristics which include a moderate amount of data; more than one level of data and it may be nested; many variables such as types of wood, drill speeds, hole diameter, and type of bit; one or two axes (such as an x and/or y axis), if there are axes; and if a low moderate graphic and a simple graphic are required to solve the problem, they should be considered a high moderate graphic. At Level 4, employees can use one high moderate graphic to locate and find information and identify the next or missing step in a process.

At Graphic Literacy Level 3, workplace graphics are common and of simple or low moderate difficulty. Characteristics of simple graphics include a limited amount of data (i.e., less than twenty data points/fields); one level of data; one or two variables; and one or two axes (such as an x and/or y axis), if there are axes. Characteristics of low moderate graphics include a moderate amount of data; more than one level of data, but no nesting; several variables; one or two axes if there are axes; and if two simple graphics are required to solve the problem, they should be considered a low moderate graphic. At Graphic Literacy Level 3, employees use one simple or low moderate graphic at a time to locate and find information and identify the next or missing step in a process.

At Graphic Literacy Level 5, workplace graphics may be less common and of low moderate, high moderate, or difficult complexity. Characteristics of low moderate graphics include a moderate amount of data; more than one level of data, but no nesting; several variables; one or two axes, if there are axes; and if two simple graphics are required to solve the problem, they should be considered a low moderate graphic. At Level 5 Graphic Literacy, employees can use a low moderate graphic to compare two or more pieces of information; interpret a trend/pattern/relationship; make a reasonable inference or decision based on one graphic after finding information in another graphic; justify a decision or inference based on information; identify the most effective graphic for the task; and justify the most effective graphic for the task. High moderate graphics may be less common at Graphic Literacy Level 5 and have characteristics which include a moderate amount of data; more than one level of data and it may be nested; many variables; one or two axes if there are axes; and if a low moderate graphic and a simple graphic are required to solve the problem, they should be considered a high moderate graphic. At Level 5 Graphic Literacy, employees can use one high moderate graphic to locate information in a graphic using information found in another graphic; compare two or more pieces of information; identify a trend/pattern/relationship; make an inference or decision; and identify the graphic that accurately represents the data. Difficult graphics at Graphic Literacy Level 5 are likely to be less common or a composite of graphics. Data presented is dense; more than one level of data and nesting is likely; there are many variables such as types of wood, drill speeds, hole diameter, and type of bit; three or more axes, such as an x, y, and z axis, if there are axes; and if a high moderate graphic and a low moderate graphic are required to solve the problem, they should be considered a difficult graphic. At Level 5, employees can use one difficult graphic to locate and find information and identify the next or missing step in a process.

The training material itself is often presented in a simple table format. For example, the students are presented with the Key Benefits of Green Manufacturing bar chart. It is color coded and ordered from least to most. Students must find several pieces of information and compare the benefit types. As a result, Level 4 Graphic Literacy skills are required.

Students review examples of the types of documentation a company needs. This documentation includes Material Data Safety Sheets for the different types of chemicals with which the employees may work. The data is usually presented in the form of multiple tables, with the table for each section being slightly different from the other. For example, the Spill and Leak Procedure may be formatted differently from the Health Hazards Exposure Data – First Aide section. The students must learn to use the information in the different sections, as well as to understand how they are related. Depending on the chemical, some MSDS may require Level 4 skills while others require Level 5 skills. Level 5 skills would be necessary if an employee had to clean-up a spill that involved two chemicals, requiring that they review and compare MSDS sheets for both.

Students are presented with several forms and must locate each piece of information or area where information would be located, as the instructor directs them to it while providing an explanation. Some of the forms include Root Cause Analysis checklists and Incident Investigation Forms. When the students complete the checklist and Incident Investigation Form, they review and collect data from multiple other forms, gauges, and control devices. Once the data is collected, students summarize the data, compare the data, and look for trends. These steps assist them to develop Level 5 skills.

WORKPLACE DOCUMENTS

All Programs—Safety, Quality Practices & Measurement, Manufacturing Processes & Production, Maintenance Awareness, and Green Production

WorkKeys Workplace Documents is the skill people use when they read and use written text in order to do a job. The written texts include memos, letters, directions, notices, bulletins, policies, and regulations. It is often the case that these workplace communications are not necessarily well written or targeted to the appropriate audience. Workplace Documents materials do not include information that is presented graphically, such as in charts, forms, or blueprints.

According to the SMEs, the online, computer-based simulation training provides audio for all of the modules. The students are allowed to choose if they want to read the audio or prefer to read the onscreen material themselves. However, students will have to read the quizzes; and if they look up a word in the glossary, they will need to read it.

To determine the level of Workplace Documents skill needed for the tasks employees complete on the job, the SMEs considered the difficulty of the reading materials and how hard it is for employees to find the information they need and make use of it. The SMEs evaluated their work situation as it compares to WorkKeys Workplace Documents skill Levels 3 through 6.

The SMEs in the Safety, Quality, and Green groups agreed that a Level 4 is required to enter into the program and that their skills will not increase by the time they exit the program. The SMEs in the Manufacturing and Maintenance groups decided that students could enter with Level 3 skills, but that they should have Level 5 skills by the time they exit the program.

At Workplace Documents Level 3, reading materials include basic work related policies, procedures, and announcements. Materials are short, with no extra information. Employees read the materials to find out what they should do. All the information within the document is stated clearly and directly. Short sentences and common, everyday, and workplace words are used. The document contains a small number of clearly stated details. When employees use Level 3 skills they can find the main ideas and clearly stated details, choose when to perform each step in a series of short steps, and apply information/instructions to a situation that is the same as the one they are reading about.

At Workplace Documents Level 4, reading materials include policies, procedures, and notices. Materials are straightforward with some long sentences and contain a number of details. These materials use common words, but do have some harder words, too. They describe procedures that include several steps. When following procedures, employees must think about changing conditions that affect what they should do. For example, they can follow directions that include if-then statements. When employees use Level 4 skills they can identify the main idea and details that may not be clearly stated, use the reading material to figure out the meaning of words that are not defined for them (not jargon or technical terms), apply information/instructions to a situation that is the same as the situation in the reading materials, and choose what to do when changing conditions call for a different action.

The students may need to read a description of a situation, apply their knowledge, and then decide if the piece of equipment meets the requirement (e.g., at least 20 means that 25 qualifies). When completing the Quality modules, the students read the instructions describing how to construct a histogram and then apply that information to a situation that is similar to what was covered in the training material. In the Manufacturing module, they learn a lot of new jargon relating to Lean Principles; however, all of the words are defined. In the Maintenance module, students are required to apply complex instructions that include conditionals to situations described in the materials. They learn a large number of technical terms and apply the knowledge when reading about situations that are similar but not the same when completing the quizzes. The Green module also contains a lot of new terminology that students will be introduced to and then need to be able to apply when completing the quizzes.

As was stated previously, SMEs in the Manufacturing and Maintenance modules decided that students should have Level 5 Workplace Documents skills by the time they exit the program. At Workplace Documents Level 5, reading materials include policies, procedures, announcements, legal, and multiple related documents that have many details. The information that employees need is generally stated directly, but it is hard to find because there are so many details and some may not be needed for the task being performed (extraneous information). The materials include technical terms, jargon, and acronyms, or words that have several meanings. The documents may have complex sentences and/or contain conditional situations. When employees use Level 5 skills they can figure out the appropriate meaning of a word based on how the word is used. They can identify the appropriate meaning of technical term, jargon, or an acronym that is defined in the document. They can apply technical terms and jargon to stated situations. Employees can apply information/instructions to a new situation that is similar to the one described in the material while considering changing conditions. At Level 5, employees can apply complex information/instructions that include conditionals to situations described in the materials. Employees may need to make some inferences to accomplish their goal.

Section 4

Results and Recommendations

The results of this project and review of its findings can be used to help guide the selection of students into the program and to encourage skill development for those applicants whose skills currently do not match the recommendations for entry. The table shows the results for entry- and exit-level performance for the five individual certificate modules. Entry level is defined as the students' first day in the program, before they gain program specific knowledge from training or experience. Exit level is the point at which a student has successfully completed the training requirements. The exit levels are provided for use as training goals.

The results of this curriculum profile support the claim that the ACT NCRC helps ensure that individuals have the academic and employability skills needed to enter a demanding MSSC advanced manufacturing production technician (CPT) certification program of training and assessment. Accelerating the use of these credentials will help individuals find jobs and provide employers with workers who have the academic, employability and 21st century advanced manufacturing and logistics skills important to success.

The Manufacturing Skill Standards Council and ACT should continue to recognize the benefits to relative stake-holders of “stacking” MSSC certification credentials upon ACT’s WorkKeys Assessments, specifically the National Career Readiness Certificate (NCRC) as the “foundation” for MSSC’s Certified Production Technician (CPT) credentialing program.

Skill Level Recommendations for Entry into the CPT Individual Certificate Modules

WorkKeys Skill	Workplace Documents	Graphic Literacy	Applied Math
Skill Level Range	3–7	3-7	3–7
Safety	4	3	Not Required
Quality Practices & Measurement	4	4	4
Manufacturing Processes & Production	3	4	4
Maintenance Awareness	3	4	4
Green Production	4	4	3
Overall Entry Level	4	4	4

Skill Level Recommendations for Exit from the CPT Individual Certificate Modules

WorkKeys Skill	Workplace Documents	Graphic Literacy	Applied Math
Skill Level Range	3-7	3-7	3-7
Safety	4	3	Not Required
Quality Practices & Measurement	4	4	4
Manufacturing Processes & Production	5	6	5
Maintenance Awareness	5	6	6
Green Production	4	5	4
Overall Entry Level	5	5	5

APPLIED MATH SKILL

WorkKeys® Applied Math is the skill people use when they use mathematical reasoning and problem-solving techniques to solve work-related problems. Employees may use calculators and conversion tables to help with the problems, but they still need to use math skills to think them through.

There are five levels of difficulty. Level 3 is the least complex and Level 7 is the most complex. The levels build on each other, each incorporating the skills assessed at the previous levels. For example, at Level 5, employees need the skills from Levels 3, 4, and 5. Examples are included with each level description.

When deciding what level of the Applied Math skill employees need for the tasks they do at work, consider the following questions:

- How is the information presented? That is:
- Is it presented in the same order that it is needed?
- Is it necessary to change the order that the information is in before the math can be performed?

Is all the information needed for solving the problems provided? That is:

- Is all the information presented in the right form?
- Is it necessary to do some calculations to get some of the important information?
- Does the problem require a formula?
- Does the information need to be taken from a graphic?

What kind of mathematical operations do employees perform? That is:

- Can the math problem be completed in one step?
- Does the problem need to be done in several steps?
- Is it necessary to convert measurements from one form to another, either within or between systems of measurement?

Applied Math Level 3

Level 3 problems can easily be translated from a word problem to a math equation requiring a single type of math operation. All the needed information is presented in a logical order and there is no extra information given.

When employees use Level 3 Applied Math skills on the job, they can:

- Solve problems that require a single type of mathematical operation. They add or subtract either positive or negative numbers (such as 10 or -2). They multiply or divide using only positive numbers (such as 10).
- Convert a familiar fraction (such as $\frac{1}{2}$ or $\frac{1}{4}$ to a decimal) and convert from a decimal to a common fraction; OR convert between decimals to percentages (such as 0.75 to 75%).
- Convert between familiar units of money and time (for example, one hour equals 60 minutes or $\frac{1}{2}$ of a dollar equals \$0.50)
- Add the prices of several products to reach a total, and they can make the correct change for a customer.

Applied Math Level 4

At Level 4, tasks may present information out of order and may include extra, unnecessary information. One or two operations may be needed to solve the problem. A chart, diagram, or graph may be included.

When employees use Level 4 Applied Math skills on the job, they can use the skills described at Level 3, and they can:

- Solve problems that require one or two operations. They may add, subtract, or multiply using positive or negative numbers (such as 10, -2), and they may divide positive numbers (such as 10).
- Figure out an average or mean of a set of numbers (such as $\frac{(10+11+12)}{3}$). For this they use whole numbers and decimals.
- Figure out simple ratios (such as $\frac{3}{4}$), simple proportions (such as $\frac{10}{100}$ cases), or rates (such as 10 mph).
- Add commonly known fractions, decimals, or percentages (such as $\frac{1}{2}$, .75, or 25%).
- Add or subtract fractions that share a common denominator (such as $\frac{1}{8} + \frac{3}{8} + \frac{7}{8}$).
- Multiply a mixed number (such as $12\frac{1}{8}$) by a whole number or decimal.
- Put the information in the right order before they perform calculations.

For example, at this level, employees can figure out sales tax or a sales commission on a previously calculated total, and they can find out rates of use or business flow.

Applied Math Level 5

In Level 5 problems, the information may not be presented in logical order; the item may contain extraneous information; it may contain a chart, graph or diagram; and the mathematical set-up may be complicated. In solving, the test taker may need to perform multiple operations. For example, at this level employees may complete an order form by totaling an order and then computing tax.

When employees use Level 5 Applied Math skills on the job, they can use the skills described at Levels 3 and 4, and they can:

- Decide what information, calculations, or unit conversions to use to find the answer to a problem.
- As part of a multiple step problem, the employee may have to find one value and use it to find another value that answers the question.
- Add and subtract fractions with unlike denominators (such as $\frac{1}{2} - \frac{1}{4}$).
- Convert units within or between systems of measurement (e.g., time, measurement, and quantity) where the formula is provided such as converting from ounces to pounds or from centimeters to inches.
- Solve problems that require mathematical operations Calculate using mixed units, such as adding 3.50 hours and 4 hours 30 minutes or subtracting 3 feet and 10 inches from 6 feet and 4 inches.
- Identify the best deal by doing one- and two-step calculations and then comparing the results to determine the solution that meets the stated conditions.
- Calculate perimeters, circumference, and areas of basic shapes like rectangles and circles.
- Calculate a given percentage of a given number and then use that percentage to determine the solution (e.g., find the total cost of a product after calculating discount, markup or tax).
- Identify where a mistake occurred in a calculation (such as identifying the row in a spreadsheet where a problem occurred).

Applied Math Level 6

Level 6 tasks may require considerable translation from verbal form to mathematical expression. They generally require considerable setup and involve multiple-step calculations.

When employees use Level 6 Applied Math skills on the job, they can use the skills described at Levels 3, 4, and 5, and they can:

- Use fractions with unlike denominators and calculate reverse percentages.
- Convert units within or between systems of measurement (e.g., time, measurement, and quantity) where multiple-step conversions are required and the formulas are provided such as converting from kilometers to meters to feet.
- Identify why a mistake occurred in a solution.
- Find the best deal and use the result for another calculation.
- Find the area of basic shapes (rectangles and circles) when it may be necessary to rearrange the formula, convert units of measurement in the calculations, or use the result in further calculations.
- Find the volume of rectangular solids.
- Calculate rates, production rates, rate by time (such as, production rate is 59 cups produced per hour, how many will be produced in an 8 hour shift).
- Identify the correct equation for solving a problem

Applied Math Level 7

At Level 7, the task may be presented in an unusual format and the information presented may be incomplete or require the employee to make an assumption. Tasks often involve multiple steps of logic and calculation, and multiple operations.

When employees use Level 7 Applied Math skills on the job, they can use the skills described at Levels 3, 4, 5, and 6, and they can:

- Solve problems that include ratios, rates, or proportions with at least one of the quantities related to a fraction
- Identify the reason for a mistake.
- Convert between units of measurement that involve fractions, mixed numbers, decimals, or percentages.
- Find the area of multiple shapes or find the area of a composite shape.
- Calculate volumes of spheres, cylinders, or cones
- Calculate the volume when it may be necessary to rearrange the formula, convert units of measurement in the calculations, or use the result in further calculations
- Set up and manipulate ratios, rates or proportions where at least one of the quantities is a fraction.
- Determine the better economic value of several alternatives by using graphics or by finding a percentage difference or a unit cost.
- Apply basic statistical concepts for example calculate the weighted mean, interpret measures of central tendency, or interpret measure of spread and tolerance.

GRAPHIC LITERACY SKILL

The WorkKeys Graphic Literacy skill is the skill people use when they work with workplace graphics such as tables, graphs, charts, digital dashboards, flow charts, timelines, forms, maps, and blueprints. Employees use this skill when they find, summarize, compare, and analyze information to make decisions using workplace graphics to solve work-related problems.

There are five levels. Level 3 is the least complex and Level 7 is the most complex. At each new level, employees need more demanding skills in addition to the skills used at the previous levels. For example, Level 5 includes the skills used at Levels 3, 4, and 5. At the lower levels, employees may need to locate or find information in a simple graphic. At the higher levels, employees may use information in one or more difficult graphics to draw conclusions and make decisions. The complexity can also increase as the quantity and/or density of the information increases.

Skill levels depend on two things: the complexity of the graphic and the task that the employee is asked to perform. When you consider what skill level is needed for the tasks that employees complete on the job, think about the following things:

How complex is the workplace graphic?

- Is the graphic simple or difficult, common or uncommon?
- Is the content familiar or unfamiliar?
- How many graphics are there? Is there one graphic, two graphics, multiple graphics, or a composite graphic (such as a bar chart with a line graph over it)?
- How many pieces of information are presented? Is there a lot of data presented or not very much?
- How many variables are there? Are there one or two variables such as weight and age or are there many variables such as height, weight, age, gender, and body mass index?
- If there are axes, how many are there (such as x and y)?
- How many levels of data are there? Is the data nested such as major cities within states?

How complicated is the employee's task when using the graphics? That is:

- Is it only necessary to locate, find, or compare information in a single graphic, or is it necessary to use the information in another graphic?

- Does the next step in a process or procedure need to be identified?
- Do trends, patterns, or relationships in a graphic need to be identified, compared, or interpreted?
- Is the information in the graphic used to make inferences or decisions? Does the inference or decision need to be justified?
- Is it necessary to identify the graphic that accurately represents the data or is the most effective? Does the choice need to be justified?

Graphic Literacy Level 3

At Level 3, workplace graphics are common and of simple or low moderate difficulty.

Characteristics of simple graphics include:

- A limited amount of data (i.e., less than twenty data points/fields)
- One level of data such as number of items in inventory
- One or two variables such as day of the week and number of items in inventory
- If there are axes, there will be one or two, such as an x and/or y axis

Characteristics of low moderate graphics include:

- A moderate amount of data
- More than one level of data, but no nesting
- Several variables
- If there are axes, there will be one or two
- If two simple graphics are required to solve the problem, they should be considered a low moderate graphic.

At Level 3, employees use one simple or low moderate graphic at a time to perform the following tasks:

- Locate and find information
- Identify the next or missing step in a process

Graphic Literacy Level 4

At Level 4, workplace graphics are common and of low to high moderate difficulty.

Characteristics of low moderate graphics include:

- A moderate amount of data
- More than one level of data, but no nesting
- Several variables
- If there are axes, there will be one or two
- If two simple graphics are required to solve the problem, they should be considered a low moderate graphic.

At Level 4, employees have demonstrated all of the skills defined at Level 3 and they can use one or two low moderate graphics at a time to perform the following tasks:

- Locate information in a graphic using information found in another graphic
- Compare two or more pieces of information
- Identify a trend/pattern/relationship
- Make an inference or decision
- Identify the graphic that accurately represents the data

High moderate graphics may be less common and have the following characteristics:

- A moderate amount of data
- More than one level of data and it may be nested
- Many variables such as types of wood, drill speeds, hole diameter, and type of bit
- If there are axes, there will be one or two such as an x and/or y axis.
- If a low moderate graphic and a simple graphic are required to solve the problem, they should be considered a high moderate graphic.

At Level 4, employees have demonstrated all of the skills defined at Level 3 and they can use one high moderate graphic to perform the following tasks:

- Locate and find information
- Identify the next or missing step in a process

Graphic Literacy Level 5

At Level 5, workplace graphics may be less common and of low moderate, high moderate, or difficult complexity.

Characteristics of low moderate graphics include:

- A moderate amount of data
- More than one level of data, but no nesting
- Several variables
- If there are axes, there will be one or two.
- If two simple graphics are required to solve the problem, they should be considered a low moderate graphic.

At level 5, employees have demonstrated all of the skills defined at Levels 3 and 4, and they can use a low moderate graphic to perform the following tasks:

- Compare two or more pieces of information
- Interpret a trend/pattern/relationship
- Make a reasonable inference or decision based on one graphic after finding information in another graphic
- Justify a decision or inference based on information
- Identify the most effective graphic for the task
- Justify the most effective graphic for the task

High moderate graphics may be less common and have the following characteristics:

- A moderate amount of data
- More than one level of data and it may be nested
- Many variables
- If there are axes, there will be one or two.
- If a low moderate graphic and a simple graphic are required to solve the problem, they should be considered a high moderate graphic.

Graphic Literacy Level 5 Continued

At Level 5, employees have demonstrated all of the skills defined at Level 3 and 4, and they can use one high moderate graphic to perform the following tasks:

- Locate information in a graphic using information found in another graphic
- Compare two or more pieces of information
- Identify a trend/pattern/relationship
- Make an inference or decision
- Identify the graphic that accurately represents the data

Difficult graphics are likely to be less common or a composite of graphics and have the following characteristics:

- Data presented is dense.
- More than one level of data and nesting is likely
- Many variables such as types of wood, drill speeds, hole diameter, and type of bit
- If there are axes, there will be three or more such as an x, y, and z axis.
- If a high moderate graphic and a low moderate graphic are required to solve the problem, they should be considered a difficult graphic.

At Level 5, employees have demonstrated all of the skills defined at Level 3 and 4, and they can use one difficult graphic to perform the following tasks:

- Locate and find information
- Identify the next or missing step in a process

Graphic Literacy Level 6

At Level 6, workplace graphics may be less common and of high moderate or difficult complexity.

High moderate graphics may be less common and have the following characteristics:

- A moderate amount of data
- More than one level of data and it may be nested
- Many variables
- If there are axes, there will be one or two
- If a low moderate graphic and a simple graphic are required to solve the problem, they should be considered a high moderate graphic.

At level 6, employees have demonstrated all of the skills defined at Levels 3, 4 and 5, and they can use a high moderate graphic to perform the following tasks:

- Compare two or more pieces of information
- Interpret a trend/pattern/relationship
- Make a reasonable inference or decision based on one graphic after finding information in another graphic
- Justify a decision or inference based on information
- Identify the most effective graphic for the task
- Justify the most effective graphic for the task

Difficult graphics are likely to be less common or a composite of graphics and have the following characteristics:

- Data presented is dense.
- More than one level of data and nesting is likely
- Many variables
- If there are axes, there will be three or more.
- If a low moderate graphic and a high moderate graphic are required to solve the problem, they should be considered a difficult graphic.

Graphic Literacy Level 6 Continued

At Level 6, employees have demonstrated all of the skills defined at Level 3, 4 and 5, and they can use one difficult graphic to perform the following tasks:

- Locate information in a graphic using information found in another graphic
- Compare two or more pieces of information
- Identify a trend/pattern/relationship
- Make an inference or decision
- Identify the graphic that accurately represents the data

Graphic Literacy Level 7

At Level 7, workplace graphics may be less common and of difficult complexity.

Difficult graphics are likely to be less common or a composite of graphics and have the following characteristics:

- Data presented is dense.
- More than one level of data and nesting is likely
- Many variables
- If there are axes, there will be three or more.
- If a low moderate graphic and a high moderate graphic are required to solve the problem, they should be considered a difficult graphic.

At level 7, employees have demonstrated all of the skills defined at Levels 3, 4, 5 and 6, and they can use a difficult graphic to perform the following tasks:

- Compare two or more trends/patterns/relationships
- Interpret a trend/pattern/relationship
- Make a reasonable inference or decision based on one graphic after finding information in another graphic
- Justify an inference or decision based on information
- Identify the most effective graphic for the task
- Justify the most effective graphic for the task

WORKPLACE DOCUMENTS SKILL

WorkKeys Workplace Documents is the skill people use when they read and use written text in order to do a job. The written texts include memos, letters, directions, notices, bulletins, policies, and regulations. It is often the case that these workplace communications are not necessarily well written or targeted to the appropriate audience. Workplace Documents materials do not include information that is presented graphically, such as in charts, forms, or blueprints.

There are five levels of difficulty. Level 3 is the least complex and Level 7 is the most complex. The levels build on each other, each incorporating the skills assessed at the preceding levels. For example, at Level 5, employees need the skills from Levels 3, 4, and 5. The reading materials at Level 3 are short and direct. The material becomes longer, denser, and more difficult to use as readers move toward Level 7. The tasks also become more complex as readers move from Level 3 to Level 7. At Level 3, readers begin by finding very obvious details and following short instructions. At the more complex levels, tasks can also involve more application and interpretation.

When you consider what level of Workplace Documents skill is needed for the tasks employees complete on the job, you might consider the following questions:

How difficult are the materials? For example:

- Are the sentences short, simple, and clear, or are they complex and possibly even confusing?
- Do the materials use only common words, or do they include difficult words, jargon, and words used in unfamiliar ways?
- How much extra information is included?

How complicated is the task? For example:

- Is it only necessary to use information that is stated clearly?
- Is it necessary to draw conclusions based on the reading materials before using the information?
- Do the employees need to apply the information to a situation exactly like the one described in the materials or to one that is quite different?

Workplace Documents Level 3

Level 3 reading materials include basic company policies, procedures, and announcements. They are short and simple, with no extra information. Employees read the materials to find out what they should do. All the information they need is stated clearly and directly, using easy words and straightforward sentences.

When employees use Level 3 Workplace Documents skills on the job, they can:

- Pick out the main ideas and clearly stated details.
- Choose the correct meaning of a word when the word is clearly defined in the reading.
- Choose the correct meaning of common everyday and workplace words (such as employee, timecard, office).
- Choose when to perform each step in a short series of steps.
- Apply instructions to a situation that is the same as the one they are reading about (such as knowing what button to push first after reading instructions on how to run a copy machine).

Workplace Documents Level 4

Level 4 reading materials include company policies, procedures, and notices. They are straightforward, but have longer sentences and contain a number of details. These materials use common words, but do have some harder words, too. They describe procedures that include several steps. When following the procedures, employees must think about changing conditions that affect what they should do.

When employees use Level 4 Workplace Documents skills on the job, in addition to using Level 3 skills, they can:

- Identify important details that may not be clearly stated.
- Use the reading material to figure out the meaning of words that are not defined for them.
- Apply instructions with several steps to a situation that is the same as the situation in the reading materials.
- Choose what to do when changing conditions call for a different action. For example, they can follow directions that include “if-then” statements.

Workplace Documents Level 5

At Level 5, policies, procedures, and announcements have many details. The information that employees need to finish a task is stated directly, but it is hard to understand because of the way it is worded. The materials include jargon, technical terms, and acronyms or words that have several meanings. Employees must consider several factors in order to identify a course of action that will accomplish their goals.

When employees use Level 5 Workplace Documents skills on the job, in addition to using the skills described at Levels 3 and 4, they can:

- Figure out the correct meaning of a word based on how the word is used.
- Identify the correct meaning of an acronym that is defined in the document.
- Identify the meaning of a technical term or of jargon that is defined in the document.
- Apply technical terms and jargon and relate them to stated situations.
- Apply straightforward instructions to a new situation that is similar to the one described in the material.
- Apply complex instructions that include conditionals to situations described in the materials.

Workplace Documents Level 6

Level 6 materials include elaborate procedures, complicated information, and legal regulations found in all kinds of workplace documents. They use complicated sentences with difficult words, jargon, and technical terms. Most of the information is not clearly stated.

When employees use Level 6 Workplace Documents skills on the job, in addition to using the skills described at Levels 3, 4, and 5, they can:

- Identify implied details.
- Use technical terms and jargon in new situations.
- Figure out the less common meaning of a word based on the context.
- Apply complicated instructions to new situations.
- Figure out the principles behind policies, rules, and procedures.
- Apply general principles from the materials to similar and new situations.
- Explain the rationale behind a procedure, policy, or communication.

Workplace Documents Level 7

At Level 7, the reading materials are very complex. The information includes a lot of details, and the concepts are complicated. The vocabulary is difficult. Unusual jargon and technical terms are used, but they are not defined. The writing often lacks clarity and direction. Readers must draw conclusions from some parts of the reading and apply them to other parts.

When employees use Level 7 Workplace Documents skills on the job, in addition to using the skills at Levels 3, 4, 5, and 6, they can:

- Figure out definitions of difficult, uncommon words based on how they are used.
- Figure out the meaning of jargon or technical terms based on how they are used.
- Figure out the general principles behind the policies and apply them to situations that are quite different from any described in the materials.

Appendix B

Learning Objectives

The Learning Objectives for the training program are shown in the table below. An “X” in a skill column means that, according to the SMEs in the profile session, the objective on that row requires that skill.

SAFETY				
Objective/ Skill		Applied Math	Graphic Literacy	Workplace Documents
Unit 1: Learning Techniques (Textbook)				
OBJ 1	Describe types of personal learning styles			X
OBJ 2	Describe how to use personal learning styles for effective learning			X
OBJ 3	Describe how to take notes			X
OBJ 4	Describe how to read a textbook to maximize learning			X
OBJ 5	Describe how to use fellow students to improve learning			X
Unit 2: Working in Manufacturing (Textbook)				
OBJ 1	Explain why manufacturing is an excellent career choice			X
OBJ 2	Identify the major sub-industries within manufacturing		X	X
OBJ 3	Identify the challenges and rewards of working in a high-performance manufacturing workplace			X
OBJ 4	Identify major responsibilities of a frontline production worker			X
OBJ 5	Identify the six major concentrations in frontline manufacturing		X	X
OBJ 6	Explain the importance of cross-training			X
Unit 3: The Impact of Manufacturing (Textbook)				
OBJ 1	Explain the importance of MSSC certification			X
OBJ 2	Identify the key knowledge and skills required for success in production manufacturing			X
OBJ 3	Identify ways to prepare for a career in high-performance manufacturing			X

SAFETY

Objective/ Skill		Applied Math	Graphic Literacy	Workplace Documents
OBJ 4	Describe education and training programs that can prepare you for a career in high- performance manufacturing			X
OBJ 5	Describe how manufacturing impacts people and the economy			X
OBJ 6	Identify major developments in the history of manufacturing			X
OBJ 7	Explain how customer expectations affect manufacturers			X
OBJ 8	Describe the effects of the global economy on manufacturers			X
OBJ 9	Explain how regulations and standards affect manufacturers			X
Unit 4: Responding to Customer Expectations (Textbook)				
OBJ 1	Describe four ways in which manufacturers can respond to customer expectations			X
OBJ 2	Identify systems used by high-performance manufacturers to produce quality goods at the lowest possible cost		X	X
OBJ 3	Identify advanced technologies used in manufacturing			X
OBJ 4	Describe how to prepare a presentation			X
Unit 5: Best Practices Companies (Textbook)				
OBJ 1	Describe how production workers use information to coordinate workflow			X
OBJ 2	Explain how production workers ensure quality			X
OBJ 3	Identify what production workers can do to maintain a safe work area			X
OBJ 4	Identify how quality checks and audits help frontline workers meet customer needs			X
OBJ 5	Describe how work teams coordinate workflow and help manage resources			X
OBJ 6	Explain why manufacturers need to be able to customize products			X
OBJ 7	Describe how production workers monitor the production process to ensure quality and efficiency			X

SAFETY

Objective/ Skill		Applied Math	Graphic Literacy	Workplace Documents
OBJ 8	Explain how production workers ensure efficient use of resources and continuously try to improve team performance			X
OBJ 9	Explain how frontline work teams can help a company become more competitive			X
OBJ 10	Explain how inspecting products ensures that they meet customer needs and design requirements			X
OBJ 11	Identify methods production workers use to reduce waste and cut costs			X
Unit 6: Communication Skills (Textbook)				
OBJ 1	Explain why effective communicating is essential to success in manufacturing			X
OBJ 2	Identify methods for improving reading skills			X
OBJ 3	Describe techniques for effective listening			X
OBJ 4	Identify methods for improving writing skills			X
OBJ 5	Give constructive feedback			X
OBJ 6	Receive constructive feedback			X
Unit 7: Production Group Communication (Textbook)				
OBJ 1	Communicate effectively with internal customers			X
OBJ 2	Communicate effectively with external customers			X
OBJ 3	Describe techniques for making effective presentations			X
OBJ 4	Make an effective presentation			X
Unit 8: Communication Strategies (Textbook)				
OBJ 1	Communicate effectively with a diverse population			X
OBJ 2	Communicate technical information effectively			X
OBJ 3	Use E-mail to communicate information			X
OBJ 4	Use the Internet to obtain information			X
OBJ 5	Use a fax machine to communicate information			X
OBJ 6	Communicate effectively using the telephone			X
Unit 9: Production Teams (MSSC-OS1 e-learning)				
SEGMENT 1 PRODUCT DEVELOPMENT				
OBJ 1	Describe two types of customers and explain the importance of each			X

SAFETY

Objective/ Skill	Applied Math	Graphic Literacy	Workplace Documents
OBJ 2			X
SKILL 1			X
OBJ 3			X
OBJ 4			X
OBJ 5			X
SKILL 2			X
SEGMENT 2 TEAM DEVELOPMENT			
OBJ 6			X
OBJ 7			X
OBJ 8			X
OBJ 9			X
OBJ 10		X	X
SKILL 3			X
SEGMENT 3 IDEA GENERATION			
OBJ 11		X	X
OBJ 12		X	X
OBJ 13			X
SKILL 4			X
SEGMENT 4 DECISION-MAKING			
OBJ 14			X
OBJ 15			X
SKILL 5			X
SEGMENT 5 CUSTOMER SERVICE			
OBJ 16			X
OBJ 17			X
OBJ 18			X

SAFETY

Objective/ Skill		Applied Math	Graphic Literacy	Workplace Documents
OBJ 19	Describe the continuous improvement process			X
SKILL 6	Handle a customer service call			X
Unit 10: Training and Leadership (MSSC_OS2 e-learning)				
SEGMENT 1 TRAINING				
OBJ 1	Describe the types of industrial training and explain their importance			X
OBJ 2	Define cross-training and explain its importance			X
OBJ 3	Describe three methods of training		X	X
OBJ 4	Describe when to conduct training			X
OBJ 5	Describe how to conduct a training session			X
SKILL 1	Provide training to another employee			X
SEGMENT 2 PRODUCTION GROUP COMMUNICATION				
OBJ 6	Describe production group organizational structure			X
OBJ 7	Describe how to communicate production team information			X
OBJ 8	Describe the elements of a visual management program			X
OBJ 9	Describe how to set and review team goals		X	X
SKILL 2	Set and review team goals			X
SEGMENT 3 PRODUCTION TEAM ROLES				
OBJ 10	Describe the roles and responsibilities of production team members			X
OBJ 11	Describe the components of a production team member job description			X
OBJ 12	Describe how to make team member work assignments			X
SKILL 3	Make team member work assignments			X
SEGMENT 4 TEAM MEMBER SKILLS				
OBJ 13	Describe four groups of team member skills			X
OBJ 14	Describe five interpersonal communications techniques			X
SKILL 4	Use good interpersonal skills			X
OBJ 15	Describe how to manage conflict			X
SKILL 5	Resolve a conflict			X

SAFETY

Objective/ Skill		Applied Math	Graphic Literacy	Workplace Documents
Unit 11: Meeting Customer Needs (Textbook)				
OBJ 1	Identify the types of internal and external customers			X
OBJ 2	Identify the different and common needs of internal and external customers			X
OBJ 3	Explain a customer's use of a product to confirm that it will be built to meet customer needs			X
Unit 12: Safety Organization (MSSC-OS3 e-learning)				
SEGMENT 1 SAFETY RESPONSIBILITIES				
OBJ 1	Define workplace health and safety and explain its importance			X
OBJ 2	Describe the role of OSHA			X
OBJ 3	Describe the safety responsibilities within a company			X
OBJ 4	Describe how to locate safety regulations and policies			X
SKILL 1	Identify safety responsibilities of individuals and organizations			X
SEGMENT 2 SAFETY INSPECTIONS				
OBJ 5	Define an OSHA safety inspection			X
OBJ 6	Describe a walk-through safety inspection			X
OBJ 7	Explain how to report an unsafe condition			X
SKILL 2	Report an unsafe condition			X
SEGMENT 3 JOB SAFETY ANALYSIS				
OBJ 8	Define a safety audit			X
OBJ 9	Describe the purpose of a job safety analysis			X
OBJ 10	Describe how to perform a job safety analysis			X
SKILL 3	Perform a job safety analysis			X
SEGMENT 4 EMERGENCY PREPAREDNESS				
OBJ 11	Describe three categories of emergencies		X	X
OBJ 12	Describe the elements of an emergency action plan			X
OBJ 13	Describe how to respond to an emergency			X
SKILL 4	Respond to an emergency			X
SEGMENT 5 WORKPLACE BEHAVIOR				
OBJ 14	Describe the responsibilities of workplace behavior			X

SAFETY

Objective/ Skill		Applied Math	Graphic Literacy	Workplace Documents
OBJ 15	Describe guidelines for workplace behavior			X
OBJ 16	Describe how to address improper workplace behavior			X
SKILL 5	Identify and address improper workplace behavior			X
Unit 13: Personal Protective Equipment (MSSC-OS4 e-learning)				
SEGMENT 1 EYE/FACE PROTECTION				
OBJ 1	Describe 7 types of personal protective equipment		X	X
OBJ 2	Describe the types of eye/face hazards			X
OBJ 3	Describe the guidelines for eye/ face protection			X
OBJ 4	Describe the types of eye/ face protection equipment			X
SKILL 1	Select eye/ face protection for a work task			X
SEGMENT 2 HEARING PROTECTION				
OBJ 5	Describe the types of hearing hazards			X
OBJ 6	Describe the guidelines for hearing protection			X
OBJ 7	Describe the types of hearing protection equipment			X
OBJ 8	Describe how to use hearing protection equipment			X
SKILL 2	Use hearing protection devices			X
SEGMENT 3 HAND AND FOOT PROTECTION				
OBJ 9	Describe the types of hand hazards			X
OBJ 10	Describe the guidelines for hand protection			X
OBJ 11	Describe the types of hand protection equipment			X
SKILL 3	Select hand protection equipment for a work task			X
OBJ 12	Describe the types of foot hazards			X
OBJ 13	Describe the guidelines for foot protection			X
OBJ 14	Describe the types of shoes			X
SKILL 4	Select shoes for a work task			X
SEGMENT 4 HEAD AND BODY PROTECTION				
OBJ 15	Describe the types of head hazards			X
OBJ 16	Describe the guidelines for head protection			X
OBJ 17	Describe the classes of hard hats			X
SKILL 5	Select head protection equipment for a work task			X
OBJ 18	Describe the types of clothing hazards			X

SAFETY

Objective/ Skill	Applied Math	Graphic Literacy	Workplace Documents
OBJ 19			X
OBJ 20			X
SKILL 6			X
OBJ 21			X
OBJ 22			X
OBJ 23			X
OBJ 24			X
SKILL 7			X
OBJ 25			X
SKILL 8			X
Unit 14: Fire and Electrical Safety (MSSC-OS5 e-learning)			
SEGMENT 1 FIRE SAFETY			
OBJ 1		X	X
OBJ 2			X
OBJ 3			X
OBJ 4			X
SKILL 1			X
OBJ 5			X
SKILL 2		X	X
SEGMENT 2 ELECTRICAL SAFETY			
OBJ 6			X
OBJ 7			X
SKILL 3			X
OBJ 8			X
OBJ 9			X
SKILL 4		X	X
SEGMENT 3 FIRST AID PROCEDURES			
OBJ 10			X
OBJ 11			X

SAFETY

Objective/ Skill		Applied Math	Graphic Literacy	Workplace Documents
OBJ 12	Describe how to prevent blood borne pathogen exposure			X
OBJ 13	Describe the basic guidelines of applying first aid			X
OBJ 14	Describe how to apply basic first aid measures			X
SKILL 5	Apply basic first aid measures			X
SEGMENT 4 ACCIDENT PROCEDURES				
OBJ 15	Describe how to respond to a workplace accident			X
OBJ 16	Describe how to use an eyewash station			X
SKILL 6	Use an eyewash station			X
OBJ 17	Describe how to report a workplace accident			X
SKILL 7	Report a workplace accident			X
Unit 15: Work Area Safety (MSSC-OS6 e-learning)				
SEGMENT 1 HOUSEKEEPING				
OBJ 1	Describe the elements of a safe workplace			X
OBJ 2	Describe guidelines for work area housekeeping safety			X
OBJ 3	Describe guidelines for walkway and exit safety			X
SKILL 1	Analyze workplace safety			X
SEGMENT 2 WORK AREA SAFETY				
OBJ 4	Describe 3 types of safe work permits		X	X
OBJ 5	Describe safety guidelines for confined space work			X
OBJ 6	Describe safety guidelines for hot work			X
SKILL 2	Analyze safe work permit-related safety			X
SEGMENT 3 ERGONOMICS				
OBJ 7	Define ergonomics and explain its importance			X
OBJ 8	Describe the guidelines for ergonomic safety			X
OBJ 9	Describe guidelines for lifting objects			X
SKILL 3	Analyze and solve ergonomic problems			X
SEGMENT 4 PLATFORMS AND MAN LIFTS				
OBJ 10	Describe the guidelines for platform work safety			X
SKILL 4	Use platform safety guidelines			X
OBJ 11	Describe the guidelines for man lift safety			X

SAFETY

Objective/ Skill		Applied Math	Graphic Literacy	Workplace Documents
SKILL 5	Use platform and man lift safety guidelines			X
Unit 16: Hazardous Material Safety (MSSC-OS7 e-learning)				
SEGMENT 1 HAZARDOUS MATERIALS				
OBJ 1	Define a hazardous material and explain its importance			X
OBJ 2	Describe the OSHA Hazardous Communication Standard			X
OBJ 3	Describe three categories of physical hazards		X	X
OBJ 4	Describe ten categories of health hazards			X
SKILL 1	Classify hazardous material		X	X
SEGMENT 2 LABELING				
OBJ 5	Define Hazardous Material Identification System			X
OBJ 6	Describe the NFPA Hazardous Material Identification System			X
OBJ 7	Describe the DOT Hazardous Material Identification System			X
OBJ 8	Describe the NPCA Hazardous Material Identification System			X
SKILL 2	Interpret a Hazardous Material Identification label			X
SEGMENT 3 MATERIAL SAFETY DATA SHEETS				
OBJ 9	Define a Material Safety Data Sheet (MSDS)			X
OBJ 10	Describe how to interpret a Material Safety Data Sheet (MSDS)			X
OBJ 11	Describe how to locate a Material Safety Data Sheet (MSDS)			X
SKILL 3	Locate and interpret a Material Safety Data Sheet (MSDS)		X	X
SEGMENT 4 HANDLING AND STORAGE				
OBJ 12	Describe the guidelines for handling hazardous material			X
OBJ 13	Describe the guidelines for storing hazardous material			X
SKILL 4	Handle and store hazardous material			X
OBJ 14	Describe the hazardous materials role of the DOT			X

SAFETY

Objective/ Skill		Applied Math	Graphic Literacy	Workplace Documents
OBJ 15	Describe the guidelines for shipping hazardous materials			X
SKILL 5	Ship and receive hazardous materials			X
SEGMENT 5 WASTE MANAGEMENT				
OBJ 16	Define hazardous waste			X
OBJ 17	Describe the hazardous materials role of the EPA			X
OBJ 18	Describe the hazardous materials role of ISO			X
OBJ 19	Describe the guidelines for environmental safety			X
OBJ 20	Describe the guidelines of cleaning up hazardous material spills			X
SKILL 6	Clean up a hazardous material spill			X
SEGMENT 6 LUBRICANT MANAGEMENT				
OBJ 21	Describe five lubricant storage rules		X	X
OBJ 22	Describe the purpose of recycling lubricants			X
OBJ 23	Describe four methods used to recycle lubricants		X	X
OBJ 24	Describe how to dispose of spent lubricants			X
Unit 17: Tool and Machine Safety (MSSC-OS8 e-learning)				
SEGMENT 1 MACHINE SAFETY				
OBJ 1	Describe the machine operator clothing safety guidelines			X
OBJ 2	Describe the machine operation safety guidelines			X
OBJ 3	Describe the four types of machine guards			X
OBJ 4	Describe the operation of a machine interlock			X
OBJ 5	Describe the operation of emergency stop controls			X
SKILL 1	Analyze machine operator safety			X
SEGMENT 2 LOCKOUT/TAGOUT				
OBJ 6	Describe the function of an electrical lockout/tagout system			X
OBJ 7	Describe how to perform an electrical lockout/ tagout			X
SKILL 2	Perform an electrical lockout/ tagout		X	X
OBJ 8	Describe the operation of a pneumatic lockout/tagout			X
SKILL3	Perform a pneumatic lockout/ tagout		X	X
SEGMENT 3 TOOL SAFETY				

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Objective/ Skill		Applied Math	Graphic Literacy	Workplace Documents
OBJ 9	Describe the cutting tool safety guidelines			X
OBJ 10	Describe the hand tool safety guidelines			X
OBJ 11	Describe the portable power tool safety guidelines			X
OBJ 12	Describe pneumatic tool safety guidelines			X
OBJ 13	Describe compressed gas safety guidelines			X
OBJ 14	Describe the sheet metal safety guidelines			X
SKILL 4	Analyze tool safety			X
SEGMENT 4 LADDER SAFETY				
OBJ 15	Describe four types of ladders			X
OBJ 16	Describe a ladder's load rating			X
OBJ 17	Describe the ladder safety guidelines			X
OBJ 18	Describe how to use a ladder			X
OBJ 19	Describe fall safety equipment			X
SKILL 5	Use a ladder			X
Unit 18: Material Handling Safety (MSSC-OS9 e-learning)				
SEGMENT 1 EQUIPMENT MOVEMENT INTRODUCTION				
OBJ 1	Describe eight methods of equipment movement and give an application of each		X	X
OBJ 2	Describe ten equipment movement safety rules		X	X
SKILL1	Analyze equipment movement safety			X
OBJ 3	Describe how to use a pry truck to move a load			X
SKILL 2	Use a pry truck to move a load			X
SEGMENT 2 RIGGING				
OBJ 4	Define rigging and give an application			X
OBJ 5	Describe the functions of four basic components of a rigging system			X
OBJ 6	Describe six steps to size rigging components		X	X
OBJ 7	Describe the 22 rigging safety rules			X
SKILL 3	Analyze rigging safety			X
OBJ 8	Describe the operation of an electric hoist			X
SKILL4	Use an electric hoist to lift a load			X
SEGMENT 3 CRANES				

SAFETY

Objective/ Skill		Applied Math	Graphic Literacy	Workplace Documents
OBJ 9	Describe four types of cranes and give an application of each		X	X
OBJ 10	Describe eight crane safety rules			X
SKILL 5	Analyze crane safety			X
OBJ 11	Describe five types of sling arrangements for a given application			X
SKILL 6	Select a sling arrangement for a given application		X	X
SEGMENT 4 POWERED INDUSTRIAL TRUCKS				
OBJ 12	Describe 10 types of powered industrial trucks and give an application of each		X	X
OBJ 13	Describe 25 powered industrial truck safety rules			X
SKILL 7	Demonstrate powered industrial truck safety			X
OBJ 14	Describe the operation of a powered industrial truck			X
OBJ 15	Describe how to perform a powered industrial truck inspection			X
SKILL 8	Inspect a powered industrial truck			X
SKILL 9	Operate a powered industrial truck			X

QUALITY PRACTICES & MEASUREMENT

Objective/ Skill		Applied Math	Graphic Literacy	Workplace Documents
Unit 19: Blueprint Reading 1 (Multiview Drawings)				
SEGMENT 1 INTRODUCTION TO BLUEPRINT READING				
OBJ 1	Describe the function of a print.		X	X
OBJ 2	Describe two methods of creating a technical drawing.		X	X
SKILL 1	Interpret blueprint drawings when shown an object.	X	X	X
OBJ 3	Describe the function of two methods used to draw an object and give an advantage of each.			X
OBJ 4	Describe the three principal dimensions of an object.	X	X	X
OBJ 5	Explain how views are arranged in a multiview drawing.		X	X
OBJ 6	Describe a method used to visualize the views of an object in a multiview drawing.		X	X
SKILL 2	Identify Views on a Blueprint.		X	X
SEGMENT 2 MULTIVIEW DRAWINGS				
OBJ 7	Describe the function of three line types used in a multiview drawing: object, hidden, and center.		X	X
OBJ 8	Describe the function of line precedence.		X	X
SKILL 3	Identify Line Types Given a Blueprint Drawing.		X	X
OBJ 9	Describe how to choose the views for a multiview drawing.		X	X
SKILL 4	Select the front view of an object.		X	X
SEGMENT 3 INTRODUCTION TO BASIC DIMENSIONING				
OBJ 10	Describe the function on a print.		X	X
OBJ 11	Describe how to dimension a linear surface and the location of a point.	X	X	X
SKILL 5	Interpret Linear Dimension Features on a Blueprint.	X	X	X
OBJ 12	Describe how circular features are dimensioned.	X	X	X
SKILL 6	Interpret Circular Dimension features on a Blueprint.	X	X	X
OBJ 13	Describe how angular features are dimensioned.	X	X	X
SKILL 7	Interpret Angular Dimension Features on a Blueprint.	X	X	X

QUALITY PRACTICES & MEASUREMENT

Objective/ Skill		Applied Math	Graphic Literacy	Workplace Documents
OBJ 14	Describe six rules for dimensioning a multiview print.		X	X
SKILL 8	Identify dimensions of an object by reading a print drawing.	X	X	X
Unit 20: Blueprint Reading 2 (Assembly Drawings and Fasteners)				
SEGMENT 1 ADVANCED DIMENSIONING				
OBJ 1	Describe the function and dimensioning of four types of holes.	X		X
OBJ 2	Describe the function of a drawing scale.	X		X
SKILL 1	Determine a dimension of an object given an undimensioned scaled drawing.	X		X
OBJ 3	Describe the function of a title block.		X	X
SKILL 2	Interpret the information in a blueprint title block.		X	X
SEGMENT 2 SECTIONAL DRAWINGS				
OBJ 4	Describe the function of a sectional view.		X	X
OBJ 5	Describe the function of a cutting plane and a cutting plane line.		X	X
OBJ 6	Describe the function of hatch lines		X	X
SEGMENT 3 FASTENERS				
OBJ 7	Describe the function of a threaded fastener and identify its five basic parts.		X	X
OBJ 8	Describe the function of two types of threads: external and internal.		X	X
OBJ 9	Describe how to specify threaded fasteners.		X	X
SKILL 3	Identify the size and type of fastener given an example.		X	X
SEGMENT 4 ASSEMBLY DRAWINGS				
OBJ 10	List and describe two types of assembly drawings.		X	X
OBJ 11	Describe how to interpret an assembly drawing.		X	X
SKILL 4	Interpret an assembly drawing.		X	X
Unit 21: Blueprint Reading 3 (Geometric Dimensioning & Tolerancing)				
SEGMENT 1 GENERAL TOLERANCING				
OBJ 1	Define two types of conventional tolerances and explain how they are shown on a drawing.	X		X

QUALITY PRACTICES & MEASUREMENT

Objective/ Skill		Applied Math	Graphic Literacy	Workplace Documents
SKILL 1	Determine if a part dimension is within tolerance using conventional tolerancing.	X		X
OBJ 2	Define a maximum material condition.	X		X
OBJ 3	Define a least material condition.	X		X
OBJ 4	Explain how tolerance notes are used.		X	X
SKILL 2	Calculate the limits of a dimension given its tolerance.	X		X
SEGMENT 2 ASSEMBLY TOLERANCES				
OBJ 5	Define two types of fits.			X
SKILL 3	Determine the type of fit between two mating parts.	X		X
OBJ 6	Define baseline dimensioning and give an advantage.			X
SKILL 4	Identify correct baseline dimensions.			X
OBJ 7	Define a feature.			X
OBJ 8	Define a feature of size.			X
SEGMENT 3 FUNDAMENTALS OF GEOMETRIC DIMENSIONING AND TOLERANCING (GD&T)				
OBJ 9	Define geometric dimensioning and tolerancing.			X
OBJ 10	Define five types of geometric features.		X	X
OBJ 11	Define a datum and a datum feature and explain their importance.			X
OBJ 12	Define a datum reference and give its symbol.		X	X
OBJ 13	Describe how to place a datum feature symbol on a drawing.		X	X
SKILL 5	Identify the correct datum to use as a reference point.		X	X
SEGMENT 4 FEATURE CONTROL FRAMES				
OBJ 14	Describe the functions of the three parts of a feature control frame.			X
OBJ 15	Describe how to place a feature control frame on a part drawing.		X	X
SKILL 6	Select a feature control frame for a part drawing.		X	X
OBJ 16	Describe four reasons why GD&T is used.			X
Unit 22: Basic Measurement				
SEGMENT 1 SI MEASUREMENT				

QUALITY PRACTICES & MEASUREMENT

Objective/ Skill		Applied Math	Graphic Literacy	Workplace Documents
OBJ 1	Define dimensional measurement and explain its importance.			X
OBJ 2	Describe two systems of dimensional measurement used in manufacturing: U.S. Customary and S.I. Metric.			X
OBJ 3	Describe the function and construction of a machinist's rule.			X
OBJ 4	Describe how to use a metric machinist's rule.			X
SKILL 1	Use a metric rule to measure an outside length of a part.	X	X	X
SEGMENT 2 U.S. CUSTOMARY MEASUREMENT				
OBJ 5	Define measurement accuracy and explain its importance.			X
OBJ 6	Define resolution and explain its effect on accuracy.			X
OBJ 7	Describe how to use a decimal inch rule.			X
SKILL 2	Use a decimal inch rule to measure a length.	X	X	X
OBJ 8	Describe how to use a rule with a common fraction inch scale.	X		X
SKILL 3	Use a rule graduated in common fractions of an inch to measure a length.	X	X	X
SEGMENT 3 TAPE MEASURE				
OBJ 9	Describe the function and construction of a tape measure.			X
OBJ 10	Describe how to use a tape measure to measure a length.			X
SKILL 4	Use a tape measure to measure a length.	X	X	X
OBJ 11	Describe four sources of measurement error.			X
SEGMENT 4 MEASUREMENT CONVERSION				
OBJ 12	Describe how to convert measurements made in common inch fractions to decimal inches.	X		X
SKILL 5	Convert between common inch fractions and decimal inches.	X		X
OBJ 13	Describe how to convert between the U.S. Customary System and the SI Metric System.	X		X
SKILL 6	Convert between U.S. customary units and S.I. metric units.	X		X

QUALITY PRACTICES & MEASUREMENT

Objective/ Skill		Applied Math	Graphic Literacy	Workplace Documents
Unit 23: Precision Measurement Tools				
SEGMENT 1 DIAL CALIPER				
OBJ 1	Describe the function of a precision measurement tool and give an example.			X
OBJ 2	Describe the function of a dial caliper and give an application.			X
OBJ 3	Describe how to use a dial caliper.		X	X
ACTIVITY 1	Dial caliper operation			X
SKILL 1	Calibrate a dial caliper.	X	X	X
SKILL 2	Use a caliper to measure an outside length of a part.	X	X	X
SKILL 3	Use a caliper to measure an inside length of a part.	X	X	X
OBJ 4	State the typical accuracy of a dial caliper measurement and explain what affects it.	X		X
SEGMENT 2 DIGITAL CALIPER				
OBJ 5	Describe the function of a digital caliper and give an application.	X		X
OBJ 6	Describe how to use a digital caliper.			X
ACTIVITY 2	Digital caliper operation.		X	X
OBJ 7	State the typical accuracy of a digital caliper and explain what affects it.			X
SKILL 4	Use a digital caliper to measure an outside length of a part.	X	X	X
SKILL 5	Use a digital caliper to measure an inside length of a part.	X	X	X
SEGMENT 3 ENGLISH MICROMETER				
OBJ 8	Describe the function of a micrometer and give an application.		X	X
OBJ 9	Describe how to use an outside micrometer.	X		X
ACTIVITY 3	Micrometer operation.	X	X	X
SKILL 6	Use an outside micrometer graduated in English units to measure the length of a part.	X	X	X
SEGMENT 4 METRIC MICROMETER				
SKILL 7	Use an outside micrometer graduated in metric units to measure the outside length of a part.	X	X	X

QUALITY PRACTICES & MEASUREMENT

Objective/ Skill		Applied Math	Graphic Literacy	Workplace Documents
SKILL 8	Use a micrometer to measure the outside diameter of a cylindrical part.	X	X	X
OBJ 10	Describe how to use an inside micrometer.	X		X
OBJ 11	State the typical accuracy of an outside micrometer and explain what affects it.	X		
Unit 24: Dimensional Gauging				
SEGMENT 1 INTRODUCTION TO GAUGING				
OBJ 1	Define a tolerance and explain its importance.	X		X
OBJ 2	Describe the function of two methods gauging and give an application of each.			X
OBJ 3	Describe the function of two types of indicators and give an application of each.			X
OBJ 4	Describe how to use a dial indicator to measure a length.	X		X
ACTIVITY 1	Dial indicator operation.	X	X	X
SEGMENT 2 INDICATOR MEASUREMENT				
OBJ 5	Describe the function of a gauge block.			X
ACTIVITY 2	1-2-3 GAUGE BLOCK INSPECTION		X	X
OBJ 6	Describe the function of mastering.	X		X
SKILL 1	Master a dial indicator.	X	X	X
SKILL 2	Measure a dimension using a dial indicator.	X	X	X
OBJ 7	Describe how to use a digital indicator to measure length.	X		X
OBJ 8	Describe the function of a gauge fixture and give an application.			X
SEGMENT 3 DATA COLLECTION				
OBJ 9	Describe three ways to collect process data and give an advantage of each.			X
OBJ 10	Describe the function of a historical data set.			X
SKILL 3	Collect and display data using data acquisition software.	X	X	X
Unit 25: Quality Systems				
SEGMENT 1 QUALITY SYSTEMS				
OBJ 1	Define product quality.			X
OBJ 2	Explain the four classifications of Quality Costs.			X

QUALITY PRACTICES & MEASUREMENT

Objective/ Skill		Applied Math	Graphic Literacy	Workplace Documents
OBJ 3	Describe elements of a quality management system.			X
OBJ 4	Define ISO 9000.			X
OBJ 5	Describe the Total Quality Management System.			X
OBJ 6	Describe the Six Sigma Quality System.			X
SEGMENT 2 CONTINUOUS IMPROVEMENT				
OBJ 7	Describe the PDCA cycle.			X
OBJ 8	Describe four methods used in improving a manufacturing process.			X
OBJ 9	Describe benchmarking.			X
OBJ 10	Describe the roles and responsibilities for quality improvement.			X
OBJ 11	Explain the impact of quality improvement on productivity			X
SEGMENT 3 INSPECTION				
OBJ 12	Describe three types of inspection.			X
OBJ 13	Define a sampling plan.			X
SKILL 1	Perform an operation according to a sampling plan.			X
OBJ 14	Describe how to perform a product inspection.	X		X
SKILL 2	Perform a product inspection.	X		X
OBJ 15	Describe how to process a non-conforming product.			X
OBJ 16	Describe how to document a non-conforming product.			X
SEGMENT 4 AUDITS				
OBJ 17	Describe the purpose of a quality audit.			X
OBJ 18	Describe three types of quality audits.			X
OBJ 19	Describe the procedure for a quality audit.			X
OBJ 20	Describe the purpose of a material review board.			X
Unit 26: Quality Improvement				
OBJ 1	Discuss the importance of data collection.			X
OBJ 2	List statistical tools used in process improvement.			X
OBJ 3	Describe methods of process improvement.			X

QUALITY PRACTICES & MEASUREMENT

Objective/ Skill		Applied Math	Graphic Literacy	Workplace Documents
OBJ 4	Define benchmarking.			X
OBJ 5	Describe how to use a PDCA cycle for continuous improvement.			X
OBJ 6	Describe data analysis in relation to quality.			X
Unit 27: Introduction to Statistical Process Control (SPC)				
SEGMENT 1 BASIC STATISTICAL CONCEPTS				
OBJ 1	Define the function of statistical process control and give an application.	X		X
OBJ 2	Define two types of variation and explain their importance.			X
SKILL 1	Identify the type of variation given a cause.			X
OBJ 3	Define central tendency and explain how it is used.			X
OBJ 4	Define three measures of central tendency.			X
SKILL 2	Calculate the mean of a set of data.	X		
SKILL 3	Calculate the range of a set of data.	X		
SEGMENT 2 HISTOGRAM CONSTRUCTION				
OBJ 5	Describe the function of a histogram and give an application.			X
OBJ 6	Describe how to manually construct a histogram.	X		X
SKILL 4	Manually construct a histogram given a set of data.	X	X	
SEGMENT 3 HISTOGRAM ANALYSIS				
OBJ 7	Describe how to analyze a histogram.			X
OBJ 8	Define Cpk and explain how it is used.	X		X
SKILL 5	Analyze a histogram.	X		
Unit 28: Control Charts				
SEGMENT 1 INTRODUCTION TO CONTROL CHARTS				
OBJ 1	Describe the function of a control chart and explain its importance.			X
OBJ 2	Define two types of data.			X
SKILL 1	Classify types of given data.			X
SEGMENT 2 X-BAR AND R CHART OPERATION				

QUALITY PRACTICES & MEASUREMENT

Objective/ Skill		Applied Math	Graphic Literacy	Workplace Documents
OBJ 3	Describe the function of two types of control charts and give an application of each.			X
OBJ 4	Describe the construction of an X-bar and R chart.	X		X
OBJ 5	Describe how to record data on an X-bar and R chart.	X		X
SKILL 2	Manually record process data on an X-bar and R chart.	X	X	
SEGMENT 3 CONTROL CHART SETUP				
OBJ 6	Describe how to construct an X-bar and R chart.			X
SKILL 3	Manually construct an X-bar and R chart.	X	X	
SEGMENT 4 CONTROL CHART ANALYSIS				
OBJ 7	Describe how to apply control charts to process operation.			X
OBJ 8	Describe how to analyze a control chart.		X	X
OBJ 9	Describe how to analyze an X-bar and R chart.		X	X
SKILL 4	Analyze an X-bar and R chart.		X	X
Unit 29: Continuous Improvement - 1				
SEGMENT 1 INTRODUCTION TO QUALITY TOOLS				
OBJ 1	Describe the function of a root cause failure analysis (RCFA).			X
OBJ 2	Describe how to perform a root cause failure analysis (RCFA).			X
OBJ 3	List and describe the function of the seven quality tools.			X
OBJ 4	Describe the function and construction of three types of cause and effect diagrams.			X
OBJ 5	Describe how to construct a C&E diagram.			X
SKILL 1	Construct a C&E diagram given a set of causes.		X	X
SEGMENT 2 BRAINSTORMING				
OBJ 6	Define brainstorming and explain how it is related to cause and effect diagrams.			X
OBJ 7	Describe the six basic steps of the brainstorming process.			X
OBJ 8	Describe six methods to improve the results of the brainstorming process.			X

QUALITY PRACTICES & MEASUREMENT

Objective/ Skill		Applied Math	Graphic Literacy	Workplace Documents
SKILL 2	Create a cause and effect diagram as part of a brainstorming process.		X	X
SEGMENT 3 PARETO DIAGRAM				
OBJ 9	Identify and describe the function of the two parts of a Pareto Diagram.			X
OBJ 10	Define Pareto Analysis.			X
OBJ 11	Describe the five steps used to manually construct a Pareto Diagram.			X
SKILL 3	Manually construct a Pareto Diagram.		X	X
SEGMENT 4 PREVENTIVE AND CORRECTIVE ACTION				
OBJ 12	Describe the processes of preventive and corrective action.			X
OBJ 13	Describe how to troubleshoot a quality problem.			X
OBJ 14	Define a critical and non-critical problem.			X
OBJ 15	Describe how to document corrective action.			X
OBJ 16	Describe how to respond to a quality problem.		X	X
SKILL 4	Determine how to respond to a quality problem.		X	X
Unit 30: Continuous Improvement - 2				
OBJ 1	Identify how quality is affected by management and production workers.			X
OBJ 2	Describe how quality teams work.			X
Unit 31: Inspection				
OBJ 1	Relate inspection procedures to quality control.			X
OBJ 2	List methods of inspecting materials, processes, and final products.			X
OBJ 3	Discuss the importance of inspection documentation and record keeping.			X
Unit 32: Audits				
OBJ 1	Explain the purpose of audits.			X
OBJ 2	Describe quality audit procedures.			X
OBJ 3	Describe how to report audit results.			X
Unit 33: Prevention and Correction				
OBJ 1	Describe the difference between preventive and corrective actions.			X

QUALITY PRACTICES & MEASUREMENT

Objective/ Skill		Applied Math	Graphic Literacy	Workplace Documents
OBJ 2	Explain the root cause failure analysis process.			X
Unit 34: Documentation				
OBJ 1	Explain why verification is an essential part of any action.		X	X
OBJ 2	Describe the reporting and documenting process of preventive and corrective actions.		X	X
OBJ 3	Explain why records must be retained.		X	X

MANUFACTURING PROCESSES & PRODUCTION

Objective/ Skill	Applied Math	Graphic Literacy	Workplace Documents
Unit 35: Contacting the Customer			
OBJ 1	Describe methods manufacturers use to review customer needs on a regular basis.		X
OBJ 2	Identify methods of conveying product specifications.		X
OBJ 3	Explain how manufacturers maintain customer contact to ensure that needs are met.	X	X
Unit 36: Designing Products			
OBJ 1	Describe the major production stages.		X
OBJ 2	Identify production resources.		X
OBJ 3	Identify process and technological factors involved with producing a product.		X
Unit 37: Types of Production and Manufacturing Introduction			
OBJ 1	Identify major production types.		X
OBJ 2	Explain how to produce large quantities of goods.	X	X
OBJ 3	Explain the process for producing smaller quantities of goods.	X	X
Unit 38: Mechanical Principles			
SEGMENT 1 MECHANISMS CONCEPTS			
OBJ 1	Describe the function of a mechanism.		X
OBJ 2	Describe three common types of mechanisms and give an application of each.		X
OBJ 3	Describe six mechanism safety rules.		X
SEGMENT 2 FORCE MEASUREMENT			
OBJ 4	Define a force and give its units of measurement.		X
OBJ 5	Define weight and give its units of measurement.		X
OBJ 6	Define mass and give its units of measurement.		X
OBJ 7	Describe the function and operation of a spring scale and give an application.		X
SKILL 1	Use a spring scale to measure the weight of an object.		X
SKILL 2	Use a spring scale to measure the force of an object.		X
SEGMENT 3 TORQUE AND MOMENTS			
OBJ 8	Define torque and its unit of measurement.		X

MANUFACTURING PROCESSES & PRODUCTION

Objective/ Skill		Applied Math	Graphic Literacy	Workplace Documents
OBJ 9	Describe how to calculate torque given an application.	X	X	
SKILL 3	Calculate torque given an application.	X		
OBJ 10	Define the Law of Moments.			X
OBJ 11	Describe how to calculate the moment caused by a force.	X		X
SKILL 4	Calculate the moment caused by a force.	X		
SEGMENT 4 LEVERS AND MECHANICAL ADVANTAGE				
OBJ 12	Define a lever and explain its importance.			X
OBJ 13	Describe the operation of three types of levers.			X
OBJ 14	Describe the concept of Mechanical Advantage.			X
OBJ 15	Describe how to calculate the mechanical advantage of a lever.	X		X
SKILL 5	Calculate the mechanical advantage of a lever.	X		
SKILL 6	Measure the mechanical advantage of a lever.		X	
Unit 39: Mechanical Linkages				
SEGMENT 1 FRICTION				
OBJ 1	Define friction and explain its importance.			X
OBJ 2	Describe an example of high and low amounts of friction.			X
OBJ 3	Describe two types of friction.			X
ACTIVITY 1	Demonstration of friction.		X	X
OBJ 4	Define the coefficient of friction and give its units of measurement.			X
OBJ 5	Describe how to calculate the coefficient of friction.	X		X
SKILL 1	Calculate the coefficient of friction given application data.	X		
SKILL 2	Measure the force required to overcome friction in different applications.		X	
OBJ 6	Describe how wheels are used to reduce friction.			X
ACTIVITY 2	Demonstration of Rolling Friction.		X	X
SEGMENT 2 INCLINED PLANES				
OBJ 7	Define an inclined plane and explain its importance.			X

MANUFACTURING PROCESSES & PRODUCTION

Objective/ Skill		Applied Math	Graphic Literacy	Workplace Documents
OBJ 8	Describe how to calculate the mechanical advantage of an inclined plane.	X		X
SKILL 3	Calculate the mechanical advantage of an inclined plane.	X		
SKILL 4	Measure the mechanical advantage of an inclined plane.		X	
SEGMENT 3 LINKAGES				
OBJ 9	Define a linkage and explain its importance.			X
OBJ 10	List three types of bar linkages and give applications of each.			X
OBJ 11	Describe the construction and operation of a slider crank linkage.			X
SKILL 5	Connect and operate a slider crank linkage.		X	X
OBJ 12	Describe the construction and operation of a double rocker linkage.			X
SKILL 6	Connect and operate a double rocker linkage.		X	X
OBJ 13	Describe the construction and operation of a crank rocker linkage.			X
SKILL 7	Connect and operate a crank rocker linkage.		X	X
SEGMENT 4 CAMS				
OBJ 14	Define a cam and a cam follower and give an application.			X
SKILL 8	Connect and operate a cam and cam follower.		X	X
OBJ 15	Describe four properties of cams.			X
SKILL 9	Measure the velocity and dwell of a cam.		X	
SEGMENT 5 TURNBUCKLES				
OBJ 16	Define a turnbuckle and give an application.			X
OBJ 17	Describe the construction of a turnbuckle.			X
ACTIVITY 3	Demonstration of turnbuckle operation.		X	X
SKILL 10	Connect and operate a turnbuckle.		X	X
Unit 40: Materials				
OBJ 1	Describe material properties and sources.			X
OBJ 2	Explain why specific products use certain materials.			X
OBJ 3	Describe the purpose of finishes.			X

MANUFACTURING PROCESSES & PRODUCTION

Objective/ Skill		Applied Math	Graphic Literacy	Workplace Documents
OBJ 4	Describe the relation of fossil fuels to production materials.			X
OBJ 5	Describe how chemicals are used in high-performance manufacturing.			X
Unit 41: Material Testing, Selection, and Development				
OBJ 1	Discuss how testing materials relates to meeting the customer's needs.		X	X
OBJ 2	Identify what factors influence the selection of production materials.			X
OBJ 3	Identify new production materials.		X	X
Unit 42: Production Processes				
OBJ 1	Discuss casting processes.			X
OBJ 2	Describe how molding is used.			X
OBJ 3	List forming techniques and explain their uses.			X
OBJ 4	Describe machining processes.			X
OBJ 5	Identify methods of conditioning parts and products.			X
OBJ 6	Identify finishing processes.			X
OBJ 7	Describe assembly methods.			X
OBJ 8	Discuss separating processes.			X
OBJ 9	Explain how combining is used.			X
OBJ 10	Explain how filling processes are used.			X
Unit 43: Machining Processes				
SEGMENT 1 INTRODUCTION TO MANUFACTURING PROCESSES				
OBJ 1	Define a manufacturing process.			X
OBJ 2	Describe the functions of five types of machine tools.			X
OBJ 3	Describe the function of a CNC mill and give an advantage.			X
OBJ 4	Describe the operation of a CNC mill.			X
OBJ 5	Describe the basic concept of the cutting action in machining.			X
OBJ 6	Describe the three chip formations and their importance.			X

MANUFACTURING PROCESSES & PRODUCTION

Objective/ Skill		Applied Math	Graphic Literacy	Workplace Documents
OBJ 7	Describe the built-up edge condition of a cutting tool.			X
OBJ 8	Describe the function and operation of a file.			X
ACTIVITY 1	Machine tool identification.		X	X
SEGMENT 2 SELECTING A STOCK				
OBJ 9	Describe the shape of four common metal stock shapes.			X
SKILL 1	Determine the size of three common metal stock shapes: sheet, flat, round.		X	
SKILL 2	Select stock size and type given a part drawing.		X	
SEGMENT 3 THE PARTS OF THE BAND SAW				
OBJ 10	Describe the function of two types of band saws and give an application of each.			X
OBJ 11	Describe the operation of a horizontal band saw.			X
ACTIVITY 2	Horizontal band saw parts identification.		X	X
SEGMENT 4 BAND SAW SAFETY				
OBJ 12	Explain five rules to follow to dress safely around machinery.			X
OBJ 13	Identify the nine safety rules that should be followed before starting a band saw.			X
OBJ 14	Explain the nine safety rules that should be followed during operation of a band saw.			X
OBJ 15	Describe how to cut stock to a specified length.			X
SKILL 3	Use a horizontal band saw to cut stock to a specified length.		X	
Unit 44: Machine Tooling				
SEGMENT 1 BASIC LAYOUT				
OBJ 1	Describe the purpose of performing layout work.			X
ACTIVITY 1	Layout Tool Identification			X
OBJ 2	Describe how to use layout techniques to mark the center points of holes on a work piece.			X
SKILL 1	Use basic layout techniques to mark the center points of holes on a work piece.		X	
OBJ 3	Describe how to use a prick punch, center punch, and a ball-peen hammer to prepare holes for drilling.			X

MANUFACTURING PROCESSES & PRODUCTION

Objective/ Skill	Applied Math	Graphic Literacy	Workplace Documents
SKILL 2	Use the prick punch, center punch, and ball-peen hammer to prepare holes for drilling.	X	X
SEGMENT 2 DRILL PRESS SAFETY			
OBJ 4	Describe the operation of a floor drill press.		X
ACTIVITY 2	Drill press parts identification.		X
OBJ 5	Explain five safety rules that should be followed before starting a drill press.		X
OBJ 6	Explain the eight safety rules that should be followed during operation of a drill press.		X
SEGMENT 3 DRILL PRESS TOOLING			
OBJ 7	Describe the operation of a twist drill.		X
ACTIVITY 3	Twist drill parts identification.	X	X
OBJ 8	Describe how to determine the size of a drill.	X	
SKILL 3	Determine the size of a drill.	X	
SKILL 4	Change the spindle speeds of the floor drill press.	X	
OBJ 9	Describe how to install a twist drill into a drill chuck.		X
SKILL 5	Install a twist drill into a drill chuck	X	X
SEGMENT 4 DRILLING HOLES			
OBJ 10	Describe how to mount a work piece in a drill press vise.		X
SKILL 6	Mount a work piece in a drill press vise.		X
OBJ 11	Describe the function and operation of cutting fluid.		X
OBJ 12	Describe how to drill a hole using cutting fluid.		X
SKILL 7	Drill holes using cutting fluid.	X	X
Unit 45: Machine Operations			
SEGMENT 1 REAMING			
OBJ 1	Describe the function and operation of reaming.		X
OBJ 2	Describe how to select a drill to prepare a hole for reaming.	X	X
SKILL 1	Select a drill and drill a hole for reaming.	X	
OBJ 3	Describe how to ream a hole.		X
SKILL 2	Select a reamer and ream a hole.	X	

MANUFACTURING PROCESSES & PRODUCTION

Objective/ Skill	Applied Math	Graphic Literacy	Workplace Documents
SEGMENT 2 COUNTERSINKING			
OBJ 4	Describe the function and operation of countersinking.		X
OBJ 5	Describe how to countersink a hole.		X
SKILL 3	Select a countersink and countersink a hole.	X	X
SEGMENT 3 COUNTER-BORING			
OBJ 6	Describe the function and operation of counter-boring.		X
OBJ 7	Describe how to counter-bore a hole.		X
SKILL 4	Select a counter-bore and counter-bore a hole.	X	X
SEGMENT 4 TAPPING AND CHAMFERING			
OBJ 8	Describe the function and operation of tapping.		X
OBJ 9	Describe the function and operation of chamfering.		X
OBJ 10	Describe how to create a tapped hole.		X
SKILL 5	Select a tap and thread a hole using a tap and a tap wrench.	X	
Unit 46: Tool Usage			
OBJ 1	List common tools and describe their uses.		X
OBJ 2	Identify how tools are used in manufacturing.		X
Unit 47: Equipment Procedures			
SEGMENT 1 MACHINE SETUP AND OPERATION			
OBJ 1	Describe the role of a modern machine operator.		X
OBJ 2	Describe basic guidelines for machine setup.		X
OBJ 3	Describe how to operate an automated machine.		X
OBJ 4	Describe methods of material handling.		X
SKILL 1	Setup and operate an automated machine	X	
SEGMENT 2 MACHINE MALFUNCTIONS			
OBJ 5	Describe two classifications of machine malfunctions.		X
OBJ 6	Describe three methods of stopping a machine.		X
OBJ 7	Describe how to detect and respond to a machine malfunction.		X
SKILL 2	Respond to a machine malfunction.	X	

MANUFACTURING PROCESSES & PRODUCTION

Objective/ Skill	Applied Math	Graphic Literacy	Workplace Documents
SEGMENT 3 MACHINE TROUBLESHOOTING			
OBJ 8	Describe how to locate equipment information.		X
OBJ 9	Describe a basic machine troubleshooting procedure.		X
SKILL 3	Troubleshoot a machine problem.	X	
OBJ 10	Describe how to document machine maintenance.	X	X
OBJ 11	Describe how to issue a work order for machine maintenance.	X	X
Unit 48: Production Planning and Workflow			
SEGMENT 1 PRODUCTION PLANNING			
OBJ 1	Describe main elements of production planning.		X
OBJ 2	Describe three methods of work flow organization.		X
OBJ 3	Define three measures of capacity.		X
OBJ 4	Describe methods of eliminating bottlenecks.		X
SKILL 1	Analyze a production process to improve workflow.	X	X
SEGMENT 2 PRODUCTION DOCUMENTS			
OBJ 5	Describe the types of production documents.		X
OBJ 6	Describe how to interpret a bill of materials.	X	X
SKILL 2	Interpret a bill of materials.	X	
OBJ 7	Describe how to interpret a routing sheet.	X	X
SKILL 3	Interpret a routing sheet.	X	
SEGMENT 3 COST ESTIMATING			
OBJ 8	Describe the components of product cost.		X
OBJ 9	Describe how to calculate machine availability.		X
SKILL 4	Calculate machine availability.	X	
OBJ 10	Describe how to estimate product cost.		X
SKILL 5	Estimate product cost.	X	
SEGMENT 4 PRODUCTIVITY			
OBJ 11	Define Lean Manufacturing and explain its importance.		X
OBJ 12	Describe the tools used by lean manufacturing.		X
OBJ 13	Describe how to calculate productivity.		X

MANUFACTURING PROCESSES & PRODUCTION

Objective/ Skill	Applied Math	Graphic Literacy	Workplace Documents
SKILL 6	Calculate productivity.	X	
OBJ 14	Describe how to conduct a time and motion study.		X
OBJ 15	Describe basic methods of improving productivity.		X
SKILL 7	Identify methods of improving productivity.	X	X
Unit 49: Components			
OBJ 1	Describe the different types of inventory.		X
OBJ 2	Identify inventory maintenance costs.		X
OBJ 3	Describe supply chain components.		X
OBJ 4	Identify production time and cost estimation.		X
OBJ 5	Describe various approaches to maintenance.		X
OBJ 6	Identify the key difference between a push system and a pull system.		X
OBJ 7	Identify combinations of push systems and pull systems.	X	X
Unit 50: Production Control			
SEGMENT 1 SCHEDULING			
OBJ 1	Describe methods of scheduling production.		X
OBJ 2	Define Manufacturing Resource Planning.		X
OBJ 3	Define a master production schedule and explain its importance.		X
OBJ 4	Describe how to interpret a manufacturing work order.		X
SKILL 1	Interpret a manufacturing work order.	X	
SEGMENT 2 INVENTORY MANAGEMENT			
OBJ 5	Define just-in-time inventory management and explain its importance.		X
OBJ 6	Define Kanban and give an application.		X
OBJ 7	Define four inventory classifications.		X
OBJ 8	Describe how to requisition tools and material.		X
SKILL 2	Requisition tools and material.	X	
SEGMENT 3 PRODUCTION EFFECTIVENESS			
OBJ 9	Describe how production quality is controlled.		X
OBJ 10	Describe how production problems are solved.		X

MANUFACTURING PROCESSES & PRODUCTION

Objective/ Skill		Applied Math	Graphic Literacy	Workplace Documents
OBJ 11	Describe the PFMEA process and give an application.			X
OBJ 12	Describe the physical inventory process and give an application.			X
SEGMENT 4 PACKAGING AND SHIPPING				
OBJ 13	Describe how to interpret shipping instructions from production documentation.		X	
SKILL 3	Interpret shipping instructions from production documentation.		X	
OBJ 14	Describe how to determine packing methods for safe product shipment.		X	X
SKILL 4	Determine packing methods for safe product shipment.		X	
OBJ 15	Describe how to interpret inbound and outbound shipping documents.		X	
SKILL 5	Interpret inbound and outbound shipping documents.		X	
Unit 51: Process Documentation				
OBJ 1	Identify production document functions.		X	X
OBJ 2	Identify document retention guidelines.		X	X
OBJ 3	List the benefits of electronic data interchange (EDI).			X
Unit 52: Packaging				
OBJ 1	List the agencies that regulate packaging.			X
OBJ 2	Discuss the aspects of packaging regulated by federal agencies.			X
OBJ 3	State the inspection label purpose.			X
Unit 53: Distribution				
OBJ 1	Identify transportation system elements.			X
OBJ 2	Discuss transport methods.			X
OBJ 3	State the documentation requirements for shipping hazardous materials.		X	X

MAINTENANCE AWARENESS

Objective/ Skill		Applied Math	Graphic Literacy	Workplace Documents
Unit 54: Maintenance Awareness Introduction and Welding				
SEGMENT 1 BASIC WELDING				
OBJ 1	Define welding and explain its importance.			X
OBJ 2	Define oxy-acetylene welding and give an Application.			X
OBJ 3	Define gas metal arc welding and give an application.			X
OBJ 4	Define spot welding and give an application.			X
SKILL 1	Select a welding type for a given application.		X	X
SEGMENT 2 WELDING SAFETY				
OBJ 5	Describe rules for welding safety.			X
SKILL 2	Analyze welding safety.		X	X
OBJ 6	Describe how to safely transport and use welding cylinders.			X
OBJ 7	Describe the operation of a Gas Metal Arc-Welder.			X
OBJ 8	Describe how to weld using a GMAW welder.			X
SKILL 3	Analyze compressed gas safety.		X	X
OBJ 9	Describe five non-destructive test methods and give an application.			X
Unit 55: Basic Electrical Circuits				
SEGMENT 1 FUNDAMENTALS OF ELECTRICITY				
OBJ 1	Define electricity and give an application.			X
OBJ 2	Describe the two types of electrical current and give an application of each.			X
OBJ 3	Describe the function and operation of a circuit tester.		X	X
SKILL 1	Use a circuit tester to check a wall outlet for electricity.		X	
SEGMENT 2 ELECTRICAL CIRCUIT COMPONENTS				
OBJ 4	Describe the function of the four basic components of an electrical circuit.			X
OBJ 5	Describe the operation of two types of power supplies and give their schematic symbols.			X
OBJ 6	Describe the function of an electrical schematic.		X	X

MAINTENANCE AWARENESS

Objective/ Skill		Applied Math	Graphic Literacy	Workplace Documents
SKILL 2	Connect and operate a power supply.		X	
SEGMENT 3 MANUAL INPUT DEVICES				
OBJ 7	Describe the operation of a manual switch.			X
OBJ 8	Describe the operation of N.O. and N.C. contacts and give their schematic symbols.		X	X
OBJ 9	Describe the function of three types of manual switch operators and give an application of each.			X
OBJ 10	Describe the operation of three types of manual switch operators and give their schematic symbols.			X
SKILL 3	Connect and operate a circuit using three types of manual switches.		X	
SEGMENT 4 OUTPUT DEVICES				
OBJ 11	Describe the function of five types of electrical output devices and give an application of each.			X
OBJ 12	Describe the operation of five types of electrical output devices and give their schematic symbols.		X	X
SKILL 4	Connect and operate an electrical circuit with a resistor.		X	
SKILL 5	Connect and operate an electrical circuit with a buzzer.		X	
SKILL 6	Connect and operate an electrical circuit with a solenoid.		X	
SKILL 7	Connect and operate an electrical circuit with a motor.		X	
Unit 56: Electrical Measurement				
SEGMENT 1 VOLTAGE MEASUREMENT				
OBJ 1	Define voltage and give its units of measurement.			X
OBJ 2	Describe the function of two types of voltmeters and give their schematic symbol.		X	X
OBJ 3	Describe how to use a voltmeter to measure voltage.	X	X	
SKILL 1	Use an analog voltmeter to measure the voltage at a point referenced to ground.		X	
OBJ 4	Describe the function and operation of analog and digital multimeters.		X	X
ACTIVITY 1	Identification of digital multimeter components.		X	

MAINTENANCE AWARENESS

Objective/ Skill		Applied Math	Graphic Literacy	Workplace Documents
SKILL 2	Use a DMM to measure the voltage of a point referenced to ground.		X	
SEGMENT 2 INTRODUCTION TO SERIES AND PARALLEL CIRCUITS				
OBJ 5	Define series and parallel circuits.			X
OBJ 6	Describe the voltage characteristics in series and parallel circuits.	X		X
ACTIVITY 2	Voltage characteristics of series and parallel circuits.		X	X
SKILL 3	Use a DMM to measure voltage drops in series and parallel circuits.		X	
SEGMENT 3 CURRENT MEASUREMENT				
OBJ 7	Define current and give its units of measurement.			X
OBJ 8	Describe the function of two types of ammeters and give their schematic symbol.		X	X
OBJ 9	Describe how to use an ammeter to measure current.		X	X
SKILL 4	Use a DMM to measure the electrical current.		X	
SKILL 5	Use a DMM to measure current in series and parallel circuits.		X	
OBJ 10	Describe the current characteristics in series and parallel circuits.	X		X
ACTIVITY 3	Current characteristics in series and parallel circuits.	X	X	
SEGMENT 4 RESISTANCE MEASUREMENT				
OBJ 11	Define resistance and give its units of measurement.			X
OBJ 12	Describe the function of two types of ohmmeters and give their schematic symbol.		X	X
OBJ 13	Describe how to use an ohmmeter to measure resistance.			X
SKILL 6	Use a DMM to measure the resistance of a component.		X	
OBJ 14	Describe the resistance characteristics in series and parallel circuits.	X		X
SKILL 7	Measure the resistance in series and parallel circuits.		X	
OBJ 15	Describe two methods of measuring continuity.			X

MAINTENANCE AWARENESS

Objective/ Skill		Applied Math	Graphic Literacy	Workplace Documents
SKILL 8	Test the continuity of wires using a DMM.		X	
Unit 57: Electrical Power				
SEGMENT 1 OHM'S LAW				
OBJ 1	State the formula for calculating series resistance and give an application.	X		X
SKILL 1	Calculate series resistance given each load's resistance.	X		
OBJ 2	State Ohm's Law, explain its importance and give an application.			X
SKILL 2	Use Ohm's Law to calculate voltage, current, and resistance in a series circuit.	X		
OBJ 3	State Kirchhoff's voltage law for a series circuit and give an application.	X		X
ACTIVITY 1	Verification of Kirchhoff's Voltage Law.	X		
SEGMENT 2 POWER IN SERIES CIRCUITS				
OBJ 4	Define power and give its units of measurement.			X
OBJ 5	State a formula for calculating the total power used in an electrical circuit.		X	X
SKILL 3	Calculate the total power used by a series circuit.	X		
SEGMENT 3 CIRCUIT PROTECTION DEVICES				
OBJ 6	Describe the function of two types of circuit protection and give an application of each.		X	X
OBJ 7	Describe the operation of a fuse and give its schematic symbol.		X	
SKILL 4	Operate a circuit using a fuse.		X	
SKILL 5	Test and replace a fuse.		X	
OBJ 8	Describe the operation of two types of circuit breakers and give their schematic symbols.		X	
SKILL 6	Operate a circuit using a circuit breaker.		X	
SKILL 7	Test and reset a circuit breaker.		X	
SEGMENT 4 AC MOTOR CONNECTIONS				
OBJ 9	Describe the operation of multiphase AC electricity and explain how it is used.			X
OBJ 10	Describe how to connect an AC motor to power.		X	
SKILL 8	Connect an AC motor to power lines.		X	

MAINTENANCE AWARENESS

Objective/ Skill	Applied Math	Graphic Literacy	Workplace Documents
SEGMENT 5 MOTOR CIRCUIT COMPONENTS			
OBJ 11	Describe the operation of two types of overcurrent protection in a motor control circuit.		X
OBJ 12	Describe the operation of four types of overload protection in a motor control circuit.		X
OBJ 13	Describe the function of conduit and list five types.	X	X
OBJ 14	Describe the operation of a magnetic motor starter.	X	X
OBJ 15	Describe how to connect a motor control circuit to power.	X	
SKILL 9	Connect a motor control circuit to power.	X	
Unit 58: Pneumatic Power Systems			
SEGMENT 1 INTRODUCTION TO PNEUMATICS			
OBJ 1	Define pneumatics and give an application.		X
OBJ 2	Describe the functions of basic components of a pneumatic system.	X	
OBJ 3	Define pneumatic pressure and give its units of measurement.		X
OBJ 4	Describe how to read a pressure gauge.	X	
SKILL 1	Read a pneumatic pressure gauge.	X	
OBJ 5	Describe two methods of representing pressure.		X
OBJ 6	Describe the function of a pneumatic schematic.		X
SEGMENT 2 PNEUMATIC POWER			
OBJ 7	Explain six pneumatic safety rules.		X
OBJ 8	Describe the function of a pressure regulator valve and give an application.	X	
OBJ 9	Describe the operation of a pressure regulator and give its schematic symbol.	X	
SKILL 2	Connect and adjust a pressure regulator.	X	
OBJ 10	Describe the function of an air filter.		X
OBJ 11	Describe the operation of an air filter and give its schematic symbol.	X	
SKILL 3	Drain a pneumatic filter.	X	
SEGMENT 3 CIRCUIT CONNECTIONS			

MAINTENANCE AWARENESS

Objective/ Skill		Applied Math	Graphic Literacy	Workplace Documents
OBJ 12	Describe the function of a pneumatic quick-connect fitting and give its schematic symbol.		X	
SKILL 4	Connect a pneumatic hose that uses quick-connect fittings.		X	
OBJ 13	Describe the function of a tee and a cross and give their schematic symbols.		X	
SKILL 5	Use a tee to connect two circuit branches together.		X	
SKILL 6	Use a cross to connect three circuit branches together.		X	
SEGMENT 4 BASIC CYLINDER CIRCUITS				
OBJ 14	Describe the function of a pneumatic cylinder and give an application.		X	
OBJ 15	Describe the operation of a double-acting pneumatic cylinder and give its schematic symbol.		X	
ACTIVITY 1	Basic operation of a double-acting cylinder.		X	
OBJ 16	Describe the function of a 5-way, 3-position pneumatic DCV and give an application.		X	
OBJ 17	Describe the operation of a 5-way, 3-position pneumatic DCV and give its schematic symbol.		X	
OBJ 18	Describe how DCVs are classified.			X
OBJ 19	Describe the function of a DCV schematic.			X
SKILL 7	Connect and operate a double-acting pneumatic cylinder using a 3-position, manually-operated DCV.		X	
Unit 59: Hydraulic Power Systems				
SEGMENT 1 INTRODUCTION TO HYDRAULICS				
OBJ 1	Define hydraulics and give an application.			X
OBJ 2	Describe the functions of five basic components of a hydraulic system.		X	
OBJ 3	Describe the operation of a hydraulic power unit.		X	
SEGMENT 2 BASIC CYLINDER CIRCUITS				
OBJ 4	Describe the function of a hydraulic schematic.			X
OBJ 5	Describe the eight basic rules for drawing hydraulic schematics.		X	

MAINTENANCE AWARENESS

Objective/ Skill		Applied Math	Graphic Literacy	Workplace Documents
OBJ 6	Describe the function of a hydraulic cylinder and give an application.		X	
OBJ 7	Describe the operation of a double-acting cylinder and give its schematic symbol.		X	
OBJ 8	Describe the function of a 3-position, 4-way DCV and give an application.		X	
OBJ 9	Describe the operation of a 3-position, 4-way DCV and give its schematic symbol.		X	
SEGMENT 3 BASIC MOTOR CIRCUITS				
OBJ 10	Describe the function of a hydraulic motor and give an application.			X
OBJ 11	Describe the operation of a hydraulic motor and give its schematic symbol.		X	
OBJ 12	List three types of hydraulic motors and give an application of each.		X	
SEGMENT 4 FILTRATION				
OBJ 13	Describe the function of a filter and give its symbol.		X	
OBJ 14	List four filter placement locations and explain when each is used.			X
OBJ 15	Describe the construction and operation of a suction strainer.		X	
OBJ 16	Describe the construction and operation of a pressure filter.		X	
OBJ 17	Describe the construction and operation of a cartridge type filter.		X	
OBJ 18	Describe the construction and operation of a spin-on filter.		X	
OBJ 19	Explain how hydraulic filters are rated.		X	
OBJ 20	Define filter dirt holding capacity.			X
OBJ 21	Describe how to determine when a filter element needs changing.			X
Unit 60: Lubrication Concepts				
SEGMENT 1 TOTAL PRODUCTIVE MAINTENANCE				
OBJ 1	Define preventative maintenance.			X
OBJ 2	Define predictive maintenance.			X

MAINTENANCE AWARENESS

Objective/ Skill		Applied Math	Graphic Literacy	Workplace Documents
OBJ 3	Define total productive maintenance.			X
SKILL 1	Perform TPM processes.		X	
SEGMENT 2 LUBRICATION CONCEPTS				
OBJ 4	Describe the six functions of a lubricant.			X
OBJ 5	Describe four types of lubricants and give an application of each.			X
OBJ 6	Describe the functions of nine types of lubricant additives.			X
OBJ 7	Describe how to analyze an oil sample.			X
OBJ 8	Describe how to take an oil sample.			X
OBJ 9	Describe the operation of five types of lubrication application methods and give an example.			X
SEGMENT 3 OILS				
OBJ 10	Describe three types of oils and give an application of each.			X
OBJ 11	Define viscosity and give its unit of measure.		X	
OBJ 12	Describe the operation of a viscometer and give an application.			X
SKILL 2	Use a viscometer to measure oil viscosity.		X	
OBJ 13	Describe how oils are specified.			X
SKILL 3	Select an oil specification for a given application.		X	
SEGMENT 4 GREASES				
OBJ 14	Describe four types of greases and give an application of each.			X
OBJ 15	Describe how greases are specified.			X
SKILL 4	Select a grease specification for a given application.		X	
OBJ 16	Describe the function and operation of a grease gun.		X	
ACTIVITY 1	Grease gun component identification.		X	
OBJ 17	Explain how to use a grease gun to lubricate a pillow block bearing.		X	
SKILL 5	Use a grease gun to lubricate a pillow block bearing.		X	
Unit 61: Bearings and Couplings				

MAINTENANCE AWARENESS

Objective/ Skill		Applied Math	Graphic Literacy	Workplace Documents
SEGMENT 1 MECHANICAL POWER TRANSMISSION SAFETY				
OBJ 1	Describe the function of a mechanical power transmission system and give an advantage.			X
OBJ 2	Describe five methods of rotary mechanical power transmission and give an application of each.			X
OBJ 3	Describe five rules of safe dress for working with power transmission equipment.			X
OBJ 4	Describe eight mechanical transmission safety rules.			X
OBJ 5	Describe the operation of the lockout/tagout system.		X	
SKILL 1	Perform a lockout/tagout.		X	
SEGMENT 2 INTRODUCTION TO BEARINGS				
OBJ 6	Describe the function of a bearing and give an application.			
OBJ 7	Define three types of bearing loads and give an example of each.			X
OBJ 8	Describe how bearings are positioned to support a load.		X	
OBJ 9	Describe the operation of two categories of bearings and give an application of each.		X	
OBJ 10	Describe four types of antifriction bearings.		X	
OBJ 11	Describe four methods of mounting a shaft bearing and give an example of each.		X	
OBJ 12	Describe eight maintenance steps for antifriction bearings.			X
OBJ 13	Describe how to install and adjust a pillow block antifriction bearing and shaft.		X	
SKILL 2	Install and adjust a pillow block antifriction bearing and shaft.		X	
SEGMENT 3 INTRODUCTION TO COUPLINGS				
OBJ 14	Describe the function of a coupling and give an application.			X
OBJ 15	Describe the function and application of four categories of mechanical couplings.			X
OBJ 16	Describe the operation of a flexible jaw coupling.			X
OBJ 17	Describe how to install a flexible jaw coupling.			X

MAINTENANCE AWARENESS

Objective/ Skill	Applied Math	Graphic Literacy	Workplace Documents
SKILL 3	Install a flexible jaw coupling.	X	
OBJ 18	Describe the purpose of shaft alignment and give two types of misalignment.		X
OBJ 19	Describe a general procedure for shaft alignment and give four measurement methods.	X	
SEGMENT 4 GEAR DRIVES			
OBJ 20	Define a gear drive and give an application.		X
OBJ 21	Describe the functions of the main components of a gear drive system.		X
SKILL 4	Connect and operate a gear drive system.	X	
OBJ 22	Describe how to calculate the mechanical advantage of a gear drive.	X	
SKILL 5	Calculate the mechanical advantage of a gear drive.	X	
SKILL 6	Measure the mechanical advantage of a gear drive.	X	
Unit 62: Belt Drives			
SEGMENT 1 BELT DRIVE CONCEPTS			
OBJ 1	Describe the function of the three basic components of a belt drive.		X
OBJ 2	Define pitch and explain its importance.	X	
OBJ 3	Define the pitch circle, pitch diameter and pitch length of a belt drive and explain their importance.	X	
OBJ 4	Describe how to calculate the pulley ratio and explain its importance.	X	
SKILL 1	Calculate pulley ratio.	X	
OBJ 5	Describe how to calculate the shaft speed and torque of a belt drive system.	X	
SKILL 2	Calculate the shaft speed and torque of a belt drive system.	X	
SEGMENT 2 V-BELT OPERATION			
OBJ 6	List five types of belt drives and give an application of each.		X
OBJ 7	List three types of V-belts and give an application of each.		X

MAINTENANCE AWARENESS

Objective/ Skill		Applied Math	Graphic Literacy	Workplace Documents
OBJ 8	Describe the operation of a fractional HP V-belt drive.			X
OBJ 9	Describe how to install and align a V-belt drive.		X	
SKILL 3	Verify alignment of a fractional HP V-belt drive with a finished bore.			
SEGMENT 3 BELT TENSIONING				
OBJ 10	Describe how to determine belt tension for an application.			X
SKILL 4	Determine the belt deflection force for a given application.		X	
OBJ 11	Describe two methods of adjusting belt tension.		X	
SEGMENT 4 BELT TENSION MEASUREMENT				
OBJ 12	Describe three methods of measuring belt tension and give an application of each.		X	
SKILL 5	Use a belt tension tester to measure belt tension.		X	
Unit 63: Chain Drives				
SEGMENT 1 CHAIN DRIVE CONCEPTS				
OBJ 1	Describe the function of the three basic components of a chain drive.			X
OBJ 2	Describe how to calculate sprocket ratio and explain its importance.		X	
SKILL 1	Calculate sprocket ratio.	X		
OBJ 3	Describe how to calculate the shaft speed and torque of a chain drive system.		X	
SKILL 2	Calculate the shaft speed and torque of a chain drive system.	X		
SEGMENT 2 CHAIN DRIVE OPERATION				
OBJ 4	List four types of chain drives and give an application of each.			X
OBJ 5	List four types of roller chain drives and give an application of each.		X	
OBJ 6	Describe the operation of a single strand roller chain drive.		X	
OBJ 7	Describe how to install, align, and remove a roller chain drive with adjustable centers.		X	

MAINTENANCE AWARENESS

Objective/ Skill	Applied Math	Graphic Literacy	Workplace Documents
SKILL 3	Verify alignment of a roller chain drive.	X	
SEGMENT 3 CHAIN TENSIONING			
OBJ 8	Describe how to determine allowable chain sag for a given application.	X	
SKILL 4	Determine allowable chain sag for a given application.	X	
OBJ 9	Describe two methods used to adjust chain sag.		X
SEGMENT 4 CHAIN TENSION MEASUREMENT			
OBJ 10	Describe how to measure chain sag.		X
SKILL 5	Use a rule and a straight edge to measure chain sag.	X	
SKILL 6	Adjust chain sag to a specified amount using adjustable centers.	X	
SEGMENT 5 FIXED CENTER CHAIN INSTALLATION			
OBJ 11	Describe the function and operation of a master link.		X
OBJ 12	Describe two methods of installing a lightweight chain.		X
SKILL 7	Install a chain with a master link using sprocket teeth.	X	
OBJ 13	Describe the operation of a chain puller.		X
SKILL 8	Install a chain with a master link using a chain puller.	X	
Unit 64: Machine Control Concepts			
SEGMENT 1 LOGIC ELEMENTS (AND, OR)			
OBJ 1	Describe the function of relay logic control circuits.		X
OBJ 2	List the six elements of control logic.		X
OBJ 3	Describe the function of AND logic and give an application.	X	
SKILL 1	Connect and operate an AND logic control circuit.	X	
OBJ 4	Describe the function of OR logic and give an application.	X	
SKILL 2	Connect and operate an OR logic control circuit.	X	
SEGMENT 2 LOGIC ELEMENTS (NOT, NOR, NAND)			

MAINTENANCE AWARENESS

Objective/ Skill		Applied Math	Graphic Literacy	Workplace Documents
OBJ 5	Describe the function of NOT logic and give an application.	X		
SKILL 3	Connect and operate a NOT logic control circuit.		X	
OBJ 6	Describe the function of NOR logic and give an application.		X	
SKILL 4	Connect and operate a NOR logic control circuit.		X	
OBJ 7	Describe the function of NAND logic and give an application.		X	
SKILL 5	Connect and operate a NAND logic control circuit.		X	
OBJ 8	Describe the function of MEMORY logic and give an application.		X	
SEGMENT 3 LADDER DIAGRAMS				
OBJ 9	Describe the function of a ladder diagram.			X
OBJ 10	Describe the function of the four components of a ladder diagram.			X
ACTIVITY 1	Identify the four basic components of a ladder diagram.		X	
OBJ 11	Explain five rules of drawing a ladder diagram.			X
SKILL 6	Read and interpret the operation of a circuit given a ladder diagram.		X	
SKILL 7	Connect and operate a logic circuit given a ladder diagram.		X	
SKILL 8	Design a ladder diagram using one or more logic elements.		X	
SEGMENT 4 ELECTRO-PNEUMATIC SOLENOID VALVES				
OBJ 12	Describe the function of a solenoid-operated fluid power valve.			X
OBJ 13	Describe the function of a power diagram.			X
SKILL 9	Connect and operate a circuit using a solenoid valve given a ladder diagram.		X	
SKILL 10	Design a control circuit in a ladder diagram format to operate a solenoid valve.		X	
Unit 65: Machine Automation				
SEGMENT 1 RELAY OPERATION				
OBJ 1	Describe the function of an electromechanical relay and give an application.		X	

MAINTENANCE AWARENESS

Objective/ Skill		Applied Math	Graphic Literacy	Workplace Documents
OBJ 2	Describe the operation of an electromechanical relay and give its ladder diagram symbol.			X
ACTIVITY 1	Relay operation.		X	
SKILL 1	Read and interpret a basic ladder diagram with detached symbology.		X	
SEGMENT 2 RELAY APPLICATIONS				
OBJ 3	Describe the operation of a relay used to energize a fluid power valve solenoid.			X
SKILL 2	Connect and operate a relay to energize a fluid power solenoid.		X	
OBJ 4	Describe the operation of a relay performing control logic.		X	
SKILL 3	Design a logic circuit that uses a relay.		X	
OBJ 5	Describe the function and operation of a seal-in circuit.			X
SKILL 4	Connect and operate a relay to perform a seal-in function.			X
SEGMENT 3 LIMIT SWITCH OPERATION				
OBJ 6	Describe the function of a limit switch and give an application.			X
OBJ 7	Describe the operation of a limit switch and give its schematic symbol.		X	
ACTIVITY 2	Limit switch operation.		X	
OBJ 8	Describe the operation of a limit switch in an event sequencing circuit.			X
SKILL 5	Connect and operate an event sequencing circuit given a ladder diagram.			X
SKILL 6	Design a logic circuit that uses a limit switch to sequence an event.			X
SEGMENT 4 TIME-DELAY RELAYS				
OBJ 9	Describe the function of a time-delay relay and give an application.			X
OBJ 10	Describe the operation of an on-delay timer relay and give its ladder diagram symbol.		X	
SKILL 7	Connect and operate a control circuit with a timer relay.		X	
SKILL 8	Design a time-driven traffic light circuit.	X	X	

MAINTENANCE AWARENESS

Objective/ Skill		Applied Math	Graphic Literacy	Workplace Documents
OBJ 11	Describe the operation of an off-delay timer relay and give its schematic symbol.		X	
Unit 66: High Vacuum Systems				
OBJ 1	Describe the operation of High Vacuum Systems.			
OBJ 2	Discuss safety concerns associated with High Vacuum Systems.			X
Unit 67: Laser Systems				
OBJ 1	Describe the function of Laser Systems.			X
OBJ 2	Discuss safety concerns associated with Laser Systems.		X	

GREEN PRODUCTION

Objective/ Skill		Applied Math	Graphic Literacy	Workplace Documents
Unit 1: Training Workers in Environmental Issues				
OBJ 1	Describe “green” manufacturing. This includes the importance of worker training in new green trends and the impact on production workers.		X	X
OBJ 2	Identify the benefits of environmental assurance programs for workers, companies and society.		X	X
OBJ 3	Discuss why worker training in environmental issues must be current and up to date.		X	X
OBJ 4	Discuss why environmental training for workers should be documented. Requires documentation to make sure that the company addresses all important environmental issues.		X	X
OBJ 5	Describe why environmental training should include information on the latest technology advancements in manufacturing. Relates to the latest technology advancements in manufacturing.		X	X
OBJ 6	Discuss why green manufacturing is a good business practice.		X	X
Unit 2: Implement and Promote Environmental Programs, Projects, Policies and Procedures				
OBJ 1	Document required regulatory compliance information.			X
OBJ 2	Review and understand environmental policies and procedures that are communicated and posted.		X	
OBJ 3	Identify and report poor environmental practices.			X
OBJ 4	Report environmental violations.		X	
OBJ 5	Speak up if your company’s environmental assurance materials are not clear and easily understandable.			X
OBJ 6	Access environmental assurance materials in your plant.		X	
Unit 3: Conduct Environmental Incident and Hazard Investigations				
OBJ 1	Conduct a basic investigation. This includes identifying near misses, and understanding the critical role of “root cause” analysis.		X	
OBJ 2	Help to document findings that are timely and correct. This includes using all the senses of sight, sound and smell to collect important information.		X	
OBJ 3	Help ensure corrective actions are included in findings. Corrective actions are an important part of documentation.			X

GREEN PRODUCTION

Objective/ Skill		Applied Math	Graphic Literacy	Workplace Documents
OBJ 4	Provide input to auditors. This will help to ensure that corrective actions are being taken.			X
Unit 4: Conduct Preventive Environmental Inspections				
OBJ 1	Identify, report, and document conditions that present a threat to the environment.		X	
OBJ 2	Identify, report, and document possible environmental hazards in the work area.		X	
OBJ 3	Take corrective actions to eliminate potential hazards.		X	
OBJ 4	Provide required documentation and follow policies for compliance and non-compliance			X
OBJ 5	Provide input into preventive investigations. This will help to ensure they are timely, accurate and include recommendations for corrective actions.		X	
Unit 5: Monitor Environmental Aspects at Each Stage of Production				
OBJ 1	Recognize the connections between production and the environment.			X
OBJ 2	Identify, check and improve upon the parts of the production process that impact the environment.			X
OBJ 3	Use indicators, gauges and computers to inspect and analyze results.	X		
OBJ 4	Help to ensure equipment is set to control and monitor impacts to the environment.			X
OBJ 5	Monitor the use and saving of resources.		X	
OBJ 6	Monitor harmful agents to reduce impact on the environment.		X	
OBJ 7	Monitor and evaluate energy use, energy waste and emissions.		X	
OBJ 8	Identify and evaluate opportunities. This includes increasing energy-efficiency and reducing energy-related carbon emissions.	X		
Unit 6: Implement Continuous Improvements in Environmental Assurance Practices				
OBJ 1	Demonstrate knowledge of environmental issues.			X
OBJ 2	Participate in meetings and training about environmental assurance.			X
OBJ 3	Prioritize root causes of problems.			X

GREEN PRODUCTION

Objective/ Skill		Applied Math	Graphic Literacy	Workplace Documents
OBJ 4	Make suggestions to management for improvements in environmentally-related practices.			X
Unit 7: Use Advanced Materials in Production to Reduce Weight and Increase Life				
OBJ 1	Use designated equipment to monitor, measure and handle advanced materials.		X	
OBJ 2	Take energy-efficient measures on the production line.	X		
OBJ 3	Read and interpret instruments to ensure required controls.	X		
OBJ 4	Use environmental controls/levels required for production with advanced materials.	X		
OBJ 5	Follow the environmental and quality requirements of advanced materials.			X
OBJ 6	Handle advanced materials according to established requirements to minimize waste.			X
Unit 8: Reprocess Materials by Recycling and Reuse Throughout Product Life Cycle to Optimize Waste Reduction				
OBJ 1	Sort used or rejected materials to determine which should be recycled and which can be reused or repurposed in the company.		X	
OBJ 2	Place waste in proper recycling containers.			X
OBJ 3	Help to coordinate recycling activities with contractors.		X	
OBJ 4	Follow codes and labels used when recycling materials.			X
OBJ 5	Assess rejected parts to determine what to do with the defective product.			X
OBJ 6	Break down rejected products when necessary and appropriate.			X