



ACT® WORKKEYS®

CURRICULUM PROFILE AND ALIGNMENT REPORT

NATIONAL INSTITUTE FOR METALWORKING SKILLS
Measurement, Materials, & Safety Credential
Job Planning, Benchwork, & Layout Credential

JEFFERSON COLLEGE
Computer Integrated Manufacturing Curriculum

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Executive Summary

The National Institute for Metalworking Skills (NIMS), Jefferson College, and ACT recognize the benefits to stake-holders of aligning and “stacking” NIMS certification credentials upon ACT’s WorkKeys Assessments, specifically the National Career Readiness Certificate (NCRC), as the “foundation” for NIMS’s Measurement, Materials, and Safety credentialing program and the Job Planning, Benchwork, and Layout credentialing program. The results of this project and review of its findings can help guide the selection of students into the programs and encourage skill development for those applicants whose skills currently do not match the recommendations for entry.

From the college perspective, the results of this study will allow Jefferson College to embed WorkKeys assessments and curriculum into Jefferson College’s Computer Integrated Manufacturing (CIM) program and will indicate where students are upon entry into the program so a higher pass rate on the NIMS credentials can be achieved. This is a huge benefit because other programs feed into the Computer Integrated Manufacturing program such as area technical schools, the Construction and Mechanical Occupations Training Academy, and the manufacturing technician non-credit fast track program which provides 9 hours of credit for prior learning toward the CIM program. In addition, Jefferson College can use it as an exit exam, and give students the opportunity to earn a higher NCRC before entering the workforce. Finally, this will help the college to advocate at the high school level for the utilization of WorkKeys in the preparation of students interested in the field of advanced manufacturing, the CIM program, and earning NIMS credentials. Jefferson College will be able to show students that these are the WorkKeys levels they need to have a good or better chance of passing NIMS credentials.

From the instructor perspective, the process of directly linking what is taught to the credential students want to earn is tremendously helpful. Matt West, the Jefferson College CIM Instructor, was able to see how the curriculum builds and how topics come up in different classes so that students don’t just see important topics once. As a result, he was able to rearrange his curriculum to place emphasis on areas that NIMS identifies as critical. It also gave him ideas on ways to build additional real world examples into the curriculum.

“I feel that there are many ways to teach and there is more than one way to skin a cat – basically hitting on learning outcomes multiple times and making expected outcomes more clear cut. The truth is in the results.”
– Matt West,
Jefferson College CIM Instructor

The results of this study can also support formulary work with high school counselors in Jefferson County and surrounding school districts. School counselors tend to think that if a student’s grades aren’t that good they should put them in manufacturing. This report shows that higher skill levels are critical and result in reduced training time and helps students to skill up quickly in the workforce. This work also shows that skill development needs to start as early as the 7th and 8th grade. Students can’t wait until their senior year of high school to prepare for careers which require advance level skills.

METHODOLOGY

WorkKeys Curriculum Profiling 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 and alignment procedure was conducted by ACT's Principal Industrial/Organizational Psychologist and profiler Cindy Hill, Ph.D. and Bryan Herrick, Jefferson College's Director of Business & Workforce Development and ACT authorized profiler. Jefferson College CIM Instructor, Matt West, served as the Subject Matter Expert and has been trained in the delivery of NIMS certification exams. Catherine Ross, NIMS Director of Services and Lynnard Jenifer, NIMS Technical Manager participated in the planning of the study, provided resources, and reviewed the results.

The curriculum profiling and alignment procedure includes the following:

- A review of the curriculum materials including the textbooks and syllabi.
- Linking NIMS's Measurement, Materials, and Safety and the Job Planning, Benchwork, and Layout credentialing programs to the Jefferson CIM curriculum.
- A skill analysis to identify the WorkKeys skills required to accomplish each learning objective during the training program.
- Skill level-setting to determine the WorkKeys skill levels recommended for entry into and for successful completion of the two programs. WorkKeys skill and skill level descriptions can be found in Appendix A.
- A workforce development road map for the manufacturing industry to promote the creation of a talent development system that provides multiple points of entry and methods of delivery, aligns core essential workplace skill levels with educational/training/skill competency requirements leading to the achievement of industry recognized credentials and a higher skilled workforce.

RESULTS

Results of this project and the 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 results can also be utilized to develop a customized skill enhancement program for students enrolled in the program that provides students with targeted instruction designed to increase skill levels. The following tables show the percentage of learning objectives that require each skill and the WorkKeys skill level results for entry- and exit-level performance. 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. It is important to note that while there are a few learning objectives that do require WorkKeys skill levels

above 5, a student with Level 5 skills could learn how to perform those specific learning objectives.

Skill Level Recommendations for Measurement, Materials, & Safety Credential

WorkKeys Skill	Learning Objectives Linked to Skill	Skill Level Range	Entry	Exit
Applied Math	37%	3-7	4	5
Graphic Literacy	67%	3-7	4	5
Workplace Documents	100%	3-7	4	5

Skill Level Recommendations for Job Planning, Benchwork, & Layout Credential

WorkKeys Skill	Learning Objectives Linked to Skill	Skill Level Range	Entry	Exit
Applied Math	69%	3-7	4	5
Graphic Literacy	85%	3-7	4	5
Workplace Documents	100%	3-7	4	5

Section 1

NIMS Credential Review

ACT, in partnership with the Manufacturing Institute, the education and workforce development arm of the National Association of Manufacturers (MI/NAM), developed the Right Skills Now (RSN) initiative. The intent of the program was to develop a short term training program that leveraged the ACT National Career Readiness Certificate for entry into a 16 week computer numerical control (CNC) machining tool training program. Upon completion of the program, students would be prepared to earn National Institute of Metalworking Skills (NIMS) credentials: Measurement, Materials, and Safety; Job Planning, Benchwork, and Layout; CNC Operator – Turning Level 1; and CNC Operator – Milling Level 1.

In 2017, MI/NAM turned the RSN program over to NIMS where they sought to reset the program to enable broader use in both credit and non-credit programs and to increase the number of individuals earning NIMS credentials. This effort is timely as manufacturing reshoring is underway and expanding nationally. Additionally, the Congressional budget increase for Department of Defense spending most likely will result in increased manufacturing particularly in areas of CNC machining and welding.

The first step in conducting the profile and alignment was to obtain background information on the credentials from the NIMS Director of Services, Catherine Ross, and NIMS Technical Manager, Lynnard Jenifer. This included obtaining the NIMS Machining Level I Preparation Guides for the Job Planning, Benchwork, and Layout Credential and the Measurement, Materials, and Safety Credential. The Guides provide an overview of the credential and description of how it was developed. In addition, the Guide includes the areas of knowledge measured by the exam, exam content, sample question overview, exam specifications, task list, sample test items, and a key.

Section 2

Curriculum Review

Jefferson College is a student-centered comprehensive community college, committed to providing an accessible, quality college experience as it strives to meet the diverse needs of the students and the community. Superior teaching and services foster a supportive learning environment, which promotes intellectual, social, and personal growth. A strong general education curriculum, college transfer and technical programs, personal enrichment courses, and on-campus experiences prepare students to succeed in their careers, further their education, and prosper in a diverse world. Jefferson College's ongoing assessment of students, programs, and services assures that it is a responsive and progressive community college.

In the Computer Integrated Manufacturing Associate of Applied Science degree or certificate program, students learn computer integration in industrial manufacturing, which is the key to providing high precision and intricate machined metal parts into the world's growing demand for extremely technical design. With the assistance of computer aided drafting and computer aided manufacturing (CAD/CAM), the gap between manufacturing and engineering tightens. The results of this integration are higher standards of precision and quality, along with programming, set-up, and machine cycle time reduction of CNC machining centers and turning centers. Graduates are prepared to enter careers as CNC Operators, CNC Programmers, CNC Set-up, CNC Machinists, Manufacturing Technicians, and Research and Development Technicians. The program consists of four semesters.

The Jefferson College Computer Integrated Manufacturing (CIM) program has received a \$12,500 grant from the Gene Haas Foundation. Funds will be used to create a scholarship available to all students in the CIM program to cover the cost of certification exams provided by the National Institute of Metalworking Skills (NIMS). Beginning in the fall semester of 2017, students in the CIM program were given the opportunity to earn NIMS certifications in CNC Milling; CNC Turning; Drill Press Skills; Grinding Skills; Job Planning, Benchwork, and Layout; Manual Milling; Measurement, Materials, and Safety; and Turning Operations. Industry-recognized credentials provide trusted, external validation of the quality and rigor of the CIM program. Students will benefit from the increased employability and competitiveness that comes with industry certification.

Jefferson College CIM Instructor, Matt West, has been trained in the delivery of NIMS certification exams. He is a technical educator who works with community college students to learn and develop their machining skills. He is knowledgeable and passionate about manufacturing. Mr. West brings first-hand experience with top manufacturing companies to the classroom, which prepares his students for the workplace and a successful future.

During Mr. West's manufacturing career in St. Louis, Missouri, he participated in many cost reduction programs, assisted with training programs, and re-trained incumbent workers to better keep up with the growing demands of manufacturing.

Mr. West holds an Associate of Applied Science degree in Computer Integrated Manufacturing from Jefferson College and has completed Career Education coursework at the University of Central Missouri. He is highly skilled in Demand Flow technologies (DFT), Lean Manufacturing, Just in time (JIT), ISO, and 5S programs. Mr. West earned his Missouri State Teaching Certificate in Career and Technical Education, and all Level 1 Credentials through the National Institute for Metal Working Skills (NIMS).

Currently, Mr. West is a full-time instructor with the Jefferson College Computer Integrated Manufacturing (CIM) department in Hillsboro, Missouri, where he delivers instruction on many levels of manual machining, CNC machining, and other related topics including workplace ethics. Mr. West is committed to the employment of his students and works with local manufacturers to help staff their facilities. Additionally, he engages the local community by leading a team of students with service learning projects.

Section 3

Curriculum Alignment

The NIMS Machining Level I Preparation Guides provide a list of tasks that describe the competencies a machinist must have in order to receive credentials for Measurement, Materials, and Safety and Job Planning, Benchwork, and Layout. The Task List has a twofold purpose. The first purpose is to prepare machinists for credentialing. The second is to encourage instructors to apply the Task List as a measurement of the effectiveness of their curricula.

Matt West, Jefferson College Instructor and Subject Matter Expert (SME) for this project, provided the syllabi for a subset of courses that make up the Computer Integrated Manufacturing program at Jefferson College. The courses include:

MTH105	Industrial Math
MTT108	Industrial Blue Print Reading
MTT116	Dimensional Metrology
CM105	Introduction to Machining Procedures
CIM125	CNC Programming I

The first step in the alignment process was to create a list of Expected Learning Outcomes and their associated Assessment Measures for each course (Appendix B). The second step was to create a master list of Course Outlines (Appendix C). Mr. West then linked the expected learning outcomes and course outlines to each task on the list of NIMS tasks a machinist must be able to perform in order to receive credentials for Measurement, Materials, and Safety (Appendix D) and Job Planning, Benchwork, and Layout (Appendix E). The alignment confirmed that the Jefferson curriculum aligns to all of the tasks identified by NIMS as tasks that a machinist must be able to perform to receive the two credentials.

Matt West, Jefferson College Instructor, and Subject Matter Expert (SME) for this project first determined if the WorkKeys Applied Math, Workplace Documents, and Graphic Literacy skills are required to learn the NIMS tasks a machinist must have in order to receive credentials for Measurement, Materials, and Safety and Job Planning, Benchwork, and Layout. Jefferson College's ACT authorized profiler Bryan Herrick presented detailed descriptions of the WorkKeys skills and skill levels (Appendix A) to Mr. West and showed him examples of problems or situations that individuals deal with at each level. If Mr. West determined that the WorkKeys skill is required, he then determined the WorkKeys skill level required.

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.

Measurement, Materials, and Safety (MMS)

The SME indicated that the WorkKeys Applied Math skill is required to accomplish 37% of the tasks for this program. The *Precision Machining Technology* textbook is a critical component of the program. The textbook was sponsored and endorsed by NIMS and comprehensively covers all the material encountered by a student during the NIMS certification process, and was written with the Machine Level 1 Standards in mind. Jefferson College's ACT authorized profiler Bryan Herrick aligned the units and sections of the textbook to Jefferson College's learning outcomes and course outline as shown in Appendix F.

To determine the Applied Math skill level needed, the SME considered the complexity of the problems and the math the individual was required to perform. The SME compared the requirements of the training program to WorkKeys Applied Math skill Levels 3 through 7. The following table shows the percentage of tasks requiring each skill level. Students entering the program with Level 4 Applied Math skills are more likely to be successful. Upon successful completion of the program, students should have developed at least Level 5 Applied Math skills. Mr. Herrick's review found that Applied Math Levels 4 through 7 skills are required for three out of the nine relevant sections of the textbook with six of the sections not requiring Applied Math at all (see Appendix F).

Applied Math

Skill Level	Percentage of Tasks
N/A	63%
3	0%
4	10%
5	19%
6	4%
7	4%

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.

The Jefferson College training covers fractional operations such as addition, subtraction, multiplication, division and fraction to decimal conversions. However, it very quickly moves into basic algebra and solving for a variable, ratios and proportions, converting English to metric and metric to English, basic geometry, angular measurement and conversions, complementary and supplementary angles, addition and subtraction of angles, Cartesian coordinates, and basic trigonometry. Basic trigonometry includes concepts such as sum of angles, Pythagorean Theorem, sides and angles of a right triangle, trigonometric functions such as sine, cosine, and tangent. All of this is covered in a single section of the textbook.

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.

Examples of tasks performed as part of the Jefferson College training and requiring Level 5 Applied Math skills include the application of a sine bar for checking angles and gage block stacks for creating angles on a given sine plate. Gage block selection is a process that starts by examining the last or smallest decimal place of the desired combination and eliminating it while subtracting it from the remaining length of the desired combination as you proceed. The process is repeated for each remaining decimal place until the total combination has been selected.

Job Planning, Benchwork, and Layout (JPBL)

The SME indicated that the WorkKeys Applied Math skill is required to accomplish 69% of the tasks for this program. The *Precision Machining Technology* textbook is a critical component of the program. The textbook was sponsored and endorsed by NIMS and comprehensively covers all the material encountered by a student during the NIMS certification process, and was written with the Machine Level 1 Standards in mind. Jefferson College's ACT authorized profiler Bryan Herrick aligned the units and sections of the textbook to Jefferson College's learning outcomes and course outline as shown in Appendix E.

To determine the Applied Math skill level needed, the SME considered the complexity of the problems and the math individuals are required to do. The SME compared the requirements of the training program to WorkKeys Applied Math skill Levels 3 through 7. The table below shows the percentage of tasks requiring each skill level. Students entering with Level 4 Applied Math skills are more likely to be successful in the program. Upon successful completion of the program, students should have developed at least Level 5 Applied Math skills. Mr. Herrick's review found that Applied Math Level 5 skills are required for four out of the six relevant sections of the textbook with an overall range of Level 4 through 7 required for task performance (see Appendix G).

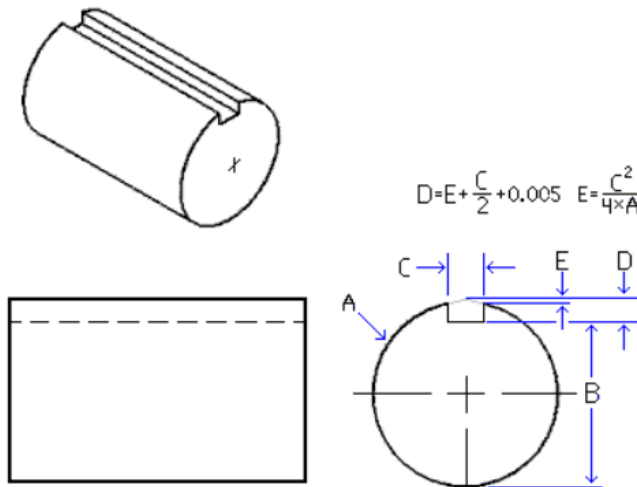
Applied Math

Skill Level	Percentage of Tasks
N/A	31%
3	5%
3-4	2%
4	39%
4-5	12%
5	9%
6	0%
7	0%

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.

Tasks Jefferson College students will learn to perform that require Level 4 and Level 5 Applied Math skills include:

- Calculating the taper per inch given parameters found in the *Machinery's Handbook*, page 685, 26th Edition – using this formula $TPI = TPF/12$
- Calculating a taper per foot using this formula $TPF = \frac{(D-d)}{\text{Length of taper}} \times 12$
- Finding the angle to the centerline when given a taper per foot using this formula $\text{Angle} = \text{TAN} \frac{TPI}{2}$
- Given a taper per foot, finding the included angle (sample: included angle, divide the .550 by 12 = .04588, hit the tangent key and the answer would be 2:37, as degrees and minutes or 2.62 degrees as a decimal)
- Applying a taper per foot formula
- Keyway and keyseat calculations



- Angle to the centerline of a taper given the taper per foot $\text{Angle} = \text{TAN} \frac{TPI}{2}$
- Definition and acronym for surface feet per minute
- Drilling – how the feed rate is designated $\text{Feed Rate} = \text{Chip Tooth} \times \#T \times \text{RPM}$

- Applying the surface feet per minute formula to find rpm

$$SFM = \text{stock diameter (in)} \times \pi \times \frac{1(ft)}{12(in)} \times \text{RPM}$$

$$\approx \text{stock diameter (in)} \times 0.2618 \times \text{RPM}$$

- Calculating cutting time

Cutting Time: minutes per operation

CT is cutting time per “pass”

L is length cut

A is “allowance” or starting offset

f_r is machine feed rate units/revolution, a Handbook Value

$$CT = \frac{(L + A)}{f_r * N}$$

- Calculating the feed rate for a milling operation
- Calculating the rpm for a drilling operation

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.

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.

Measurement, Materials, and Safety (MMS)

The SME indicated that the WorkKeys Graphic Literacy skill is required to accomplish 67% of the learning objectives for this program. Jefferson College's ACT authorized profiler Bryan Herrick aligned the units and sections of the *Precision Machining Technology* textbook to Jefferson College's learning outcomes and course outline as shown in Appendix F.

To determine the Graphic Literacy skill level needed, the SME considered the complexity of the graphics and what individuals are required to do with the graphic. The SME compared the requirements of the training program to WorkKeys Graphic Literacy skill Levels 3 through 7. The table below shows the percentage of tasks requiring each skill level. While the majority of the tasks require Level 3 Graphic Literacy skills, students are presented with Level 4 graphics very quickly. As a result, a student entering the program with Level 4 Graphic Literacy skills is more likely to be successful. Upon successful completion of the program, students should have developed at least Level 5 Graphic Literacy skills. Mr. Herrick's review also found that Graphic Literacy skill Levels 4 or Level 5 are required for six out of the nine relevant sections of the textbook with an overall range of Levels 3 through 5 required for task performance (see Appendix F).

Graphic Literacy

Skill Level	Percentage of Tasks
N/A	33%
3	40%
4	15%
5	12%
6	0%
7	0%

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.

An example of a graphic used in the Jefferson College curriculum includes Lockout/Tagout tags. These tags are simple graphics with a limited amount of data such as name, department, expected completion date, and remarks and individuals are only expected to locate information on the tag or enter information into the tag fields. Safety

markings and signage are critical. NFPA hazard labels, HMIS III, and fire triangles are also simple graphics so critical information can be found quickly especially in emergency situations. The student must understand how the colors relate to the meaning and what they are used to identify.

Simple process plans can be of low moderate difficulty depending on the number of operations and variables (e.g., description, machine, workholding, tooling, speed/feed data, date/time completed, initial). Work orders, job cards, routers, lot travelers, and standard operating procedures are a few examples of process plans. Often these documents travel with parts through machining steps and require information to be recorded and signatures of people performing particular steps. Fractional/Decimal Equivalent tables consist of four columns.

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.

A sampling/inspection plan is an example from the Jefferson College curriculum of a high moderate graphic that requires individuals to find information and requires Level 4 Graphic Literacy skills. Plans have a moderate amount of data (dimension, inspector, date, time, subgroups and subgroup summaries). Data such as print and actual may be nested with variables such as average and range.

In addition, Jefferson College students will learn to read statistical process control charts (SPC), x-bar charts, and R-charts. SPC is a sophisticated method for tracking variation in sizes of machined parts. SPC makes use of the dimensions specified in an inspection plan from the sample parts outlined in a sampling plan. SPC plots data on two types of charts to analyze trends in part variation. They are called control charts. This information helps to predict the consistency of an operation and guides adjustments to the operation before it starts to produce parts outside of tolerances. SPC software can automatically create these charts. However, individuals must be able to determine if a process is “in control” and identify trends so adjustments can be made to the machining operation to keep parts closer to the desired size and flatten out the line. The R-chart or

range chart shows the amount of variation of each sampling. R-charts must be used with X-bar charts to track machining processes. Both the x-bar and the R-charts graphs must be within their upper control limit (UCL) and their lower control limit (LCL) for the process to be “in control”. This activity requires Level 5 Graphic Literacy skills because individuals are using two low moderate graphics at a time to locate information in a graphic using information found in another graphic; comparing two or more pieces of information; identifying a trend; and making an inference or decision about what to do to bring it back “in control” if it is out of control. However, an individual with Level 4 skills will be able to learn how to do this as part of the program.

Job Planning, Benchwork, and Layout (JPBL)

The SME indicated that the WorkKeys Graphic Literacy skill is required to accomplish 85% of the tasks for this program. Jefferson College’s ACT authorized profiler Bryan Herrick aligned the units and sections of the *Precision Machining Technology* textbook to Jefferson College’s learning outcomes and course outline as shown in Appendix G.

To determine the Graphic Literacy skill level needed, the SME considered the complexity of the graphics and what individuals are required to do with the graphic. The SME compared the requirements of the training program to WorkKeys Graphic Literacy skill Levels 3 through 7. The table below shows the percentage of tasks requiring each skill level. Students entering the program with Level 4 skills are more likely to be successful. Upon successful completion of the program, students should have developed at least Level 5 Graphic Literacy skills. Mr. Herrick’s review also found that Graphic Literacy Levels 4 skills are required for four out of the six relevant sections of the textbook with an overall range of Levels 3 through 6 required for task performance (see Appendix G).

Graphic Literacy

Skill Level	Percentage of Tasks
N/A	15%
3	1%
3-4	3%
4	48%
4-5	22%
5	6%
5-6	5%
6	0%
7	0%

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.

An understanding of engineering drawings is critical for success in the machining field and is addressed in the Jefferson College curriculum. Students must be able to interpret engineering drawings or prints. Engineering drawings show the sizes and shapes of components and their specific features, such as holes, slots, or surfaces. The machined components cannot be produced independently or efficiently within the required specifications unless the drawing has been interpreted correctly. Engineering drawings can range from simple to complex, but are produced in a standard format that enables machinists anywhere to understand them. An engineering drawing is a two-dimensional representation of a three-dimension object. As a result, a drawing will have different views representing how the object would appear when looked at from a certain perspective or position. A simple part may only require one view to show all the information needed to machine it, but a more complex part will require many more views to aid in developing a mental image of its shape. The major components of an engineering drawing include the title block, orthographic projection, line types, basic symbols and notation, and tolerance. As a result, engineering drawings require at least Level 4 Graphic Literacy skills and most require Level 5 or higher. However, the students receive a great deal of instruction and hands-on practice using engineering drawings.

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.

WORKPLACE DOCUMENTS

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.

Measurement, Materials, and Safety (MMS)

The SME indicated that the WorkKeys Workplace Documents skill is required to accomplish 100% of the tasks for this program. Jefferson College's ACT authorized profiler Bryan Herrick aligned the units and sections of the *Precision Machining Technology* textbook to Jefferson College's learning outcomes and course outline as shown in Appendix F.

To determine the level of Workplace Documents skill needed, the SME considered the difficulty of the reading materials and how hard it is for individuals to find the information they need and make use of it. The SME compared the requirements of the training program to WorkKeys Workplace Documents skill Levels 3 through 7. The table below shows the percentage of tasks requiring each skill level. While the majority of the tasks require Level 5 Workplace Document skills, a student entering the program with Level 4 skills could read and comprehend the material used at the beginning of the program. Upon successful completion of the program, however, students should be accustomed to using materials Level 5 Workplace Document skills. Mr. Herrick's review also found that Workplace Documents Levels 4 or 5 skills are required for seven of the nine relevant sections of the textbook with an overall range of Levels 3 through 6 required for task performance (see Appendix F).

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.

Workplace Documents

Skill Level	Percentage of Tasks
3	12%
4	17%
5	69%
6	2%
7	0%

The textbook identifies key and secondary terms throughout the text to guide students to important points. For example, a list of key terms is provided at the beginning of each unit and each key term appears in red the first time it is used. Each section provides a bulleted summary of important information. The SME pointed out that the textbook assists the reader to identify the main ideas and specifically what they are expected to be able to do after reading the material by providing learning objectives at the beginning of each unit. For example, at the beginning of Section 2 Unit 1 the following list of learning objectives is provided:

After completing this unit, the student should be able to:
Define OSHA and describe its purpose
Define NOISH and describe its purpose
Describe appropriate clothing for a machining environment
Identify and interpret SDS (MSDS) terms
Select the proper fire extinguisher application

There separate boxes titled **CAUTION**. The following is an excerpt from this box, “*If you notice any unsafe situations or actions, report them immediately to the proper person so they can be resolved. If any type of injury occurs, immediately notify your supervisor, instructor, or other superior so that proper medical or emergency procedures can begin as soon as possible.*”

While the material is straightforward, some of the sentences can be long and contain a number of details. The following is an example, “*If compressed air must be used for a specific cleaning purpose under controlled conditions, use a nozzle that limits pressure to 30 psi or less and ensure that other guards and PPE are used according to OSHA regulations.*”

Students must apply instructions with several steps to a situation that is the same as the situation in the reading material, and they choose what to do when changing conditions call for a different action. The directions for approaching another person in a shop are a

good example, “*For that reason, when approaching another person in the shop, move toward him or her from the front and avoid quick movements or sudden noises. Wait for a “break in the action” before starting to talk. Remember that it only takes a split second for “accidents” to happen, but once they happen it is impossible to erase them.*” The student should be able to follow these steps and choose what to do when situations change.

Machining is a language of its own, and there is a lot of terminology for someone without much experience to master (e.g., flash point, lockout device, tagout, acute, chronic). There are lots of acronyms and technical jargon and it is important for the students to know what they represent (e.g., LEL, LFL, SDS, MSDS, HMIS, OSHA, STEL, TWA, and EPA). The text makes this much easier by providing Key Terms at the beginning of each unit, showing the terms in red the first time they are used, and providing a glossary.

Upon successful completion of the program, students should have developed at least Level 5 Workplace Document skills. At Workplace Documents 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, and identify the meaning of a technical term or of jargon that is defined in the document. In addition, they can 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, and apply complex instructions that include conditionals to situations described in the materials.

Job Planning, Benchwork, and Layout (JPBL)

The SME indicated that the WorkKeys Workplace Documents skill is required to accomplish 100% of the learning objectives for this program. The *Precision Machining Technology* textbook is a critical component of the program. The text is written for students at the secondary and postsecondary levels and requires no prior knowledge of machining. The textbook was sponsored and endorsed by NIMS and comprehensively covers all the material encountered by a student during the NIMS certification process, and was written with the Machine Level 1 Standards in mind. Jefferson College’s ACT authorized profiler Bryan Herrick aligned the units and sections of the textbook to Jefferson College’s learning outcomes and course outline as shown in Appendix G.

To determine the level of Workplace Documents skill needed, the SME considered the difficulty of the reading materials and how hard it is for individuals to find the information they need and make use of it. The SME compared the requirements of the

training program to WorkKeys Workplace Documents skill Levels 3 through 7. The table below shows the percentage of tasks requiring each skill level. Students entering the program with level 4 skills could read and comprehend the majority of the material. Upon successful completion of the program, students should have developed at least Level 5 Workplace Document skills. Mr. Herrick’s review also found that Workplace Documents Levels 4 and 5 skills are required for all six relevant sections of the textbook (see Appendix G).

Workplace Documents

Skill Level	Percentage of Tasks
3	1%
3-4	2%
4	60%
4-5	36%
5	1%
6	0%
7	0%

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 SME pointed out that the textbook assists the reader to identify the main ideas and specifically what they are expected to be able to do after reading the material by providing objectives for each chapter. For example, at the beginning of Chapter 3 there is an Objectives box with the following,

After completing this unit, the student should be able to:

- *Identify and interpret title block information*
- *Identify line types and their uses*
- *Demonstrate understanding of the principle of orthographic projection*
- *Identify the three basic views frequently used on engineering drawing*

There are separate boxes titled **CAUTION**. The following is an excerpt from this box, “*Layout fluid contains some hazardous materials, so review the MSDS, provided by the manufacturer for safety precautions. They will include working in an area with good ventilation, wearing safety glasses, and avoiding flame or ignition sources. Be sure to*

replace the lid on the container as soon as you are finished to avoid spills and to contain vapors.”

While the material is straightforward, some of the sentences can be long and contain a number of details. The following is an example, *“If compressed air must be used for a specific cleaning purpose under controlled conditions, use a nozzle that limits pressure to 30 psi or less and ensure that other guards and PPE are used according to OSHA regulations.”*

Students must apply instructions with several steps to a situation that is the same as the situation in the reading material, and they choose what to do when changing conditions call for a different action. The directions to dress a wheel are a good example, *“To dress the wheel, hold the wheel dresser securely on the tool rest and apply enough pressure so you can see material being removed from the surface of the wheel. Then move the dresser back and forth across the wheel until contact is made around the entire periphery of the wheel. Keep about half of the dresser, in contact with the wheel at each edge. Moving the dresser completely off either side of the wheel can round the edge of the wheel instead of keeping the surface straight.”* The student should be able to follow these steps and choose what adjustments are needed for their situation.

Machining is a language of its own, and there is a lot of terminology for someone without much experience to master (e.g., abrasive grain size, spark breaker grinding wheel dressing, wheel flange). There are lots of acronyms and technical jargon and it is important for the students to know what they represent (e.g., TPI, HSS, fpm, rpm, SAE-AISI). The text makes this much easier by providing Key Terms at the beginning of each unit, showing the terms in red the first time they are used, and providing a glossary.

Upon successful completion of the program, students should have developed at least Level 5 Workplace Document skills. At Workplace Documents 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, and identify the meaning of a technical term or of jargon that is defined in the document. In addition, they can 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, and apply complex instructions that include conditionals to situations described in the materials.

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, and 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.

Jefferson College Expected Learning Outcomes List

ID	Course	Expected Learning Outcome (Students will...)	Assessment Measure
1	CIM105 Intro to Machining Procedures	use vocabulary peculiar to the trade.	In-class discussion.
2	CIM105 Intro to Machining Procedures	identify proper safety procedures.	Class demonstrations, homework, quizzes.
3	CIM105 Intro to Machining Procedures	calculate speeds and feeds for specific cutters and applications.	Homework, Surface speed charts, lab exercises and final exam.
4	CIM105 Intro to Machining Procedures	calculate tap drill sizes for specific tap sizes.	Homework, tap drill charts, lab exercises and final
5	CIM105 Intro to Machining Procedures	select proper layout procedures and tools for part layout.	Lab exercises and final exam. NIMS Test Measurement Materials and Safety test
6	CIM105 Intro to Machining Procedures	perform precision measuring using micrometers and calipers.	Blueprints, lab exercises and final exams. Evaluate students' performance, send projects to Met Tec for assessment.
7	CIM105 Intro to Machining Procedures	operate band saw, and cut off saw to perform basic operations, hand drill, drill press operations.	Blueprints, lab exercises, final exams. Student will have opportunity to for NIMS Test, in Job planning and Bench work.
8	CIM105 Intro to Machining Procedures	operate tool room lathe to perform basic operations.	Blueprints, lab exercises, final exams.
9	CIM105 Intro to Machining Procedures	operate vertical milling machine to perform basic operations.	Blueprints, lab exercises, final exams.
10	CIM105 Intro to Machining Procedures	select and sharpen cutting tools to perform basic operations	Lab exercises and final exams.
11	CIM125 CNC Programming I	use vocabulary peculiar to the trade.	In-class discussion.
12	CIM125 CNC Programming I	write beginning programs using EIA format.	Part program printouts.

ID	Course	Expected Learning Outcome (Students will...)	Assessment Measure
13	CIM125 CNC Programming I	calculate positioning using the Cartesian coordinate system.	Handouts, class exercises, quizzes and final exam.
14	CIM125 CNC Programming I	identify basic types of cutting tools.	Handouts, class exercises, quizzes and final exam.
15	CIM125 CNC Programming I	identify G-codes and their uses.	Program printouts, lab exercises and final exam.
16	CIM125 CNC Programming I	identify M-codes and their uses.	Program printouts, lab exercises and final exam.
17	CIM125 CNC Programming I	write a part program for machining Center.	Program printouts, blue print, lab exercises and final exams.
18	CIM125 CNC Programming I	create a part on CNC Machining Centers and Turning Centers.	Lab exercises. Nims Testing CNC Mill, and CNC Turning operators Certificates.
19	MTT108 Industrial Blueprint Reading	use vocabulary peculiar to the trade.	In-class discussion, homework, and quizzes.
20	MTT108 Industrial Blueprint Reading	learn different line types and there uses.	Homework, blueprints, instructor observation, quizzes, and final exam.
21	MTT108 Industrial Blueprint Reading	demonstrate the use of different size prints and paper sizes.	Homework, blueprints, instructor observation, quizzes, and final exam.
22	MTT108 Industrial Blueprint Reading	construct 3-d view drawings using top, side, and bottom views to interpolate.	Homework, Blueprints, instructor observation, quizzes, and final exam.
23	MTT108 Industrial Blueprint Reading	determine tolerance and dimension specifications from reading Blueprints.	Homework, Blueprints, instructor observation, quizzes, and final exam.
24	MTT108 Industrial Blueprint Reading	compare accuracies of finished parts to blueprints.	Homework, Blueprints, instructor observation, quizzes, and final exam.
25	MTT108 Industrial Blueprint Reading	create Bill of materials Using information from Blueprint	Homework, Blueprints, instructor observation, quizzes, and final exam.
26	MTT116 Dimensional Metrology	use vocabulary peculiar to the trade.	In-class discussion, homework, and quizzes.

ID	Course	Expected Learning Outcome (Students will...)	Assessment Measure
27	MTT116 Dimensional Metrology	learn how measurement is essential at many levels. (Skilled, production, and scientific.)	Homework, blueprints, instructor observation, quizzes, and final exam.
28	MTT116 Dimensional Metrology	explain why statistical control is based on measurements that have already been taken.	Homework, statistical forms, instructor observation, quizzes, and final exam.
29	MTT116 Dimensional Metrology	construct statistical spreadsheets, and use it to predict what the future measurements will be.	Homework, statistical spreadsheet, instructor observation, quizzes, and final exam.
30	MTT116 Dimensional Metrology	be able to use graduated scales within recognized limitations.	Homework, instructor observation, quizzes, and final exam.
31	MTT116 Dimensional Metrology	read Vernier and dial instruments.	Homework, instructor observation, quizzes, and final exam.
32	MTT116 Dimensional Metrology	read and use Micrometer and digital instruments.	Homework, instructor observation, quizzes, and final exam.
33	MTT116 Dimensional Metrology	read and use gage blocks and production gage instruments.	Homework, instructor observation, quizzes, and final exam. Students apply knowledge to testing for Nims
34	MTH105 Industrial Math	Perform arithmetic computations, following the order of operations using; whole numbers, fractions, decimals (quick review), and scientific notation	Class discussions, quizzes, and exams
35	MTH105 Industrial Math	Perform computations with units and convert units within and between the U.S. Customary and Metric Systems	Class discussions, quizzes, and exams
36	MTH105 Industrial Math	Make accurate measurements with measurement tools commonly used in the trades	Class discussions, quizzes, and exams
37	MTH105 Industrial Math	Perform computations using formulas, and rearrange formulas into alternate forms	Class discussions, quizzes, and exams

ID	Course	Expected Learning Outcome (Students will...)	Assessment Measure
38	MTH105 Industrial Math	Compute perimeters, areas, surface areas, and volumes of plane and solid figures	Class discussions, quizzes, and exams
39	MTH105 Industrial Math	Solve problems involving percent, ratio, and proportion	Class discussions, quizzes, and exams
40	MTH105 Industrial Math	Solve algebraic equations including linear and quadratic, and solve systems of equations	Class discussions, quizzes, and exams
41	MTH105 Industrial Math	Solve problems involving right and oblique triangles by using trigonometric ratios	Class discussions, quizzes, and exams

Appendix C

Jefferson College Curriculum Course Outlines

ID	Course	Course Outline
1	CIM105 Intro to Machining Procedures	Safety 1. Eye protection 2. Long hair 3. Proper clothing 4. Jewelry 5. Lock out 6. Machine hazards
2	CIM105 Intro to Machining Procedures	Layout 1. Layout bench 2. Height gage 3. Squares and scribes
3	CIM105 Intro to Machining Procedures	Measuring Tools 1. Micrometer 2. Calipers 3. Height gages 4. Rules
4	CIM105 Intro to Machining Procedures	Tool room lathes 1. Turning 2. Drilling 3. Boring 4. Threading
5	CIM105 Intro to Machining Procedures	Vertical milling machine 1. End Milling 2. Drilling 3. Reaming 4. Tapping
6	CIM125 CNC Programming I	Uses of CNC Machines 1. CNC Mill Machining Center 2. CNC Turning Center 3. Wire EDM 4. Water Jet 5. Laser Jet
7	CIM125 CNC Programming I	Cutting Tools 1. Drills 2. End Mills 3. Carbide End Mills 4. Taps 5. Reamers 6. High Speed Cutters

ID	Course	Course Outline
8	CIM125 CNC Programming I	Beginning programs codes. 1. G01 11. G00 2. G02 12. G80 3. G03 13. G81 4. G00 14. G83 5. M00 15. G84 6. M02 16. G40 7. M03 17. G41 8. M05 18. G42 9. M08 10. M09
9	CIM125 CNC Programming I	Cartesian Coordinate System 1. Absolute Positioning 2. Incremental Positioning
10	MTT108 Industrial Blueprint Reading	Unit 1&2 - Bases for Blueprint Reading, Alphabet of lines and Object lines.
11	MTT108 Industrial Blueprint Reading	Unit 3&4 – Hidden lines, Center lines, Extension lines, and Dimension lines.
12	MTT108 Industrial Blueprint Reading	Unit 5&6 – Projection lines, other and line combinations. Three View drawings.
13	MTT108 Industrial Blueprint Reading	Unit 7&8 – Arrangement of Views, Two view drawings.
14	MTT108 Industrial Blueprint Reading	Unit 9&10- One view drawings, Auxiliary views.
15	MTT108 Industrial Blueprint Reading	Unit 11&12- Size and Location dimensions, dimensioning cylinders and arcs.
16	MTT108 Industrial Blueprint Reading	Unit 13&14- Size dimensions for holes, Location dimensions for points.
17	MTT108 Industrial Blueprint Reading	Unit 15&16&17- Base Line dimensioning, Tolerances, Unilateral & Bilateral.
18	MTT108 Industrial Blueprint Reading	Unit 18- Interchangeable parts, allowances, and Class of fit
19	MTT108 Industrial Blueprint Reading	Unit 19&20- External Screw threads, Internal and Left handed threads.
20	MTT108 Industrial Blueprint Reading	Unit 21&22- Tapers, Shop notes, Metric system dimensioning.
21	MTT116 Dimensional Metrology	Unit 23 Metric system dimensioning,

ID	Course	Course Outline
22	MTT116 Dimensional Metrology	Unit 27&28- Half sections, Partial section, Ordinate and tabular dimensioning.
23	MTT116 Dimensional Metrology	Unit 29-30 Geometric dimensioning and tolerancing. CADD/CAM/CIM
24	MTT116 Dimensional Metrology	Unit 31&32-Welding Symbols, Surface Development, and Sheet Metal Drawing
25	MTT116 Dimensional Metrology	Unit 33 Detail Drawings and Assembly Drawings.
26	MTH105 Industrial Math	Arithmetic with Whole Numbers
27	MTH105 Industrial Math	Arithmetic with Fractions
28	MTH105 Industrial Math	Measurement Tools (supplemental)
29	MTH105 Industrial Math	Arithmetic with Decimal Numbers
30	MTH105 Industrial Math	Ratio, Proportions, and Percent
31	MTH105 Industrial Math	Measurement: English and Metric
32	MTH105 Industrial Math	Beginning Algebra (evaluating, simplifying and working with algebraic expressions)
33	MTH105 Industrial Math	Intermediate Algebra (quadratic equations and systems of equations)
34	MTH105 Industrial Math	Practical Plane Geometry
35	MTH105 Industrial Math	Solid Figures
36	MTH105 Industrial Math	Fundamentals of Trigonometry
37	MTH105 Industrial Math	Statistics
38	MTH105 Industrial Math	Binary and Hexadecimal Numbers (supplemental)

Appendix D

NIMS Measurement, Materials and Safety Credential Alignment to Jefferson College Curriculum

NIMS Measurement, Materials and Safety Theory and Performance Credentialing Exams	Jefferson College		ACT WorkKeys NCRC Skills and Levels		
	Learning Outcomes	Course Outline	Workplace Documents	Graphic Literacy	Applied Math
Machine Maintenance					
Lubrication of machinery (procedure and checking oil level)	1,2	1,4,5	4	3	NA
Safe method of removing chips from machinery	2,7,11	1,4,5,6	4	3	NA
Maintenance procedure when mounting a chuck on the lathe	1,8	1,4	4	3	NA
Application of grease guns	1,2,11	1,4,5	4	3	NA
Researching Maintenance Procedures					
Instructions for general maintenance	1,2,11	1,6	5	5	4
Finding information for lubrication and maintenance of specific machinery	1,2,11	1,4,5,6	5	3	N/A
Hand Tool Safety and Maintenance					
Hand file safety	10	2,4,5	4	3	N/A
Characteristics and causes of loading, pinning, scratching, etc.	10	2	5	3	N/A
Tooling Maintenance					
Process plan and tooling maintenance	2,11,12	1,2,3,4,6,7	5	5	5
Use and application of sulphurized oil	7	4,5,	5	N/A	N/A
Description and cause of finish tears when reaming	7	4,5	5	N/A	N/A
Gage Blocks					
Calculating gage block stacks	33,41	23,28	5	N/A	6

NIMS Measurement, Materials and Safety Theory and Performance Credentialing Exams	Jefferson College		ACT WorkKeys NCRC Skills and Levels		
	Learning Outcomes	Course Outline	Workplace Documents	Graphic Literacy	Applied Math
Tools needed to use gage blocks to check heights on a surfaceplate	31,32,36	23,28	5	4	5
Gage block stacks for creating angles on a given sine plate	33,41,	23,28,36	5	5	7
Surface Finish					
Surface finish comparison charts	1,3 17,18	4,5,6,7	5	4	5
Interpretation of surface finish symbols	1,3 17,18	4,5,6,7	5	5	NA
Inspection Plan and Sampling Procedures					
Initial step for developing an inspection plan	25,29	24	5	4	5
Main criteria for determining when a part is rejected	23,27	17,22	5	4	5
Definition of a sampling	26	24	4	N/A	N/A
Rationale for having inspection plans	26,28	22,24	5	3	N/A
Main detail for determining the correct measuring tool to check a dimension	27	22	5	3	N/A
The contribution of the sampling plan to quality control	29	24	5	N/A	5
Measuring Techniques and Tools					
Application of a sine bar for checking angles	26,27	23	5	4	7
Feature of a thread checked by a thread micrometer	27	23	5	N/A	N/A
Application of gage pins for checking diameters	27	23	5	N/A	4
Feature best suited for measuring with a dial bore gage	27	23	5	N/A	N/A

NIMS Measurement, Materials and Safety Theory and Performance Credentialing Exams	Jefferson College		ACT WorkKeys NCRC Skills and Levels		
	Learning Outcomes	Course Outline	Workplace Documents	Graphic Literacy	Applied Math
SPC					
Definition of the range applied in SPC	26, 29	23	5	4	4
Chart used to measure variation between parts in a sampling	26	23,29	5	5	N/A
MSDS Knowledge					
Acronym and definition of the Lower Explosive Limit	1,2	1,2	5	4	N/A
MSDS indoctrination and safety meetings	1,2	1,2	5	3	N/A
Acronym and definition of the Threshold Limit Value	1,2	1,2	5	N/A	N/A
Basic Shop Safety					
Rationale and proper disposal of rags and wipes	1,2	1,2	4	N/A	N/A
Acronym for government agency which regulates safety and health requirements for industry	1,2	1,2	4	N/A	N/A
First course of action if materials (solids) become lodged in the eye	1,2	1,2	3	3	N/A
Safety hazards of long hair, loose clothes, and jewelry	1,2	1,2	3	3	N/A
Proper technique for lifting	1,2	1,2	3	3	N/A
Personal Protective Equipment (PPE)					
Equipment used when materials are stored overhead or hoists or cranes are utilized	1,2	1,2	3	3	N/A
Basic PPE for common machine tools such as lathes, mills, and grinders	1,2	1,2	3	3	N/A
Machine Safety					
Safety practices for milling machines	9,11	5,6	3	N/A	NA

NIMS Measurement, Materials and Safety Theory and Performance Credentialing Exams	Jefferson College		ACT WorkKeys NCRC Skills and Levels		
	Learning Outcomes	Course Outline	Workplace Documents	Graphic Literacy	Applied Math
Tapping and Threading – Process Adjustment and Improvement					
Causes of tapped holes being too tight or too loose	4,10	4,5,7	5	N/A	N/A
Percentage of thread engagement	4,12	4,5,6,7	5	N/A	N/A
Grinding – Process Adjustment and Improvement					
Grinding long slender parts and flatness concerns	1,2,10	1,3	5	N/A	4
Milling – Process Adjustment and Improvement					
Machining tough material causing excessive tool wear	3	5	5	3	5
Procedures for machining slots	9	5	5	3	N/A
Drilling – Process Adjustment and Improvement					
Drill breakage related to rpm and feed rate	3,4,12	4,5,6,7	5	3	5
Corrective action for oversized reamed holes	3,10,	5,6,7	5	N/A	4
Fits and Allowances					
Allowances for various fits (reference the Machinery's Handbook)	19, 23	18,22	5	3	5
Rationale for Process Adjustment and Improvement					
Reason to adjust and improve	29	23	6	5	6

NIMS Job Planning, Benchwork and Layout Credential Alignment to Jefferson College Curriculum

NIMS Job Planning, Benchwork, and Layout Theory and Performance Credentialing Exams	Jefferson College		ACT WorkKeys NCRC Skills and Levels		
	Learning Outcome	Course Outline	Workplace Documents	Graphic Literacy	Applied Math
Theory Exam					
Taper Problems					
Applying taper terminology and trigonometry to set a compound rest to cut a taper on the lathe	41,8 MTH 105 CIM 105	36,4	4-5	4-5	5
Calculating the taper per inch given parameters found in the <i>Machinery's Handbook</i> , page 685, 26th Edition	41,8 MTH 105 CIM 105	26,36	4-5	4-5	4
Calculating a taper per foot	41,8 MTH 105 CIM 105	26/36	4	4-5	4
Finding the angle to the centerline when given a taper per foot	41,8 MTH 105 CIM 105	34	4-5	4-5	5
Given a taper per foot, finding the included angle	41,8 MTH 105 CIM 105	36	4-5	4-5	5
Applying a taper per foot formula	41,8 MTH 105 CIM 105	32	4	4	4
Machinery's Handbook					
Find a tap drill size	4 CIM 105	5	4	4	4

NIMS Job Planning, Benchwork, and Layout Theory and Performance Credentialing Exams	Jefferson College		ACT WorkKeys NCRC Skills and Levels		
	Learning Outcome	Course Outline	Workplace Documents	Graphic Literacy	Applied Math
Keyway and keyseat calculations	39	34	4	4-5	5
Steel identification system (SAE)	2	25	4	4-5	
Angle to the centerline of a taper given the taper per foot	41	36	4-5	4-5	5
Finding thread parameters (minor diameter, pitch diameter, etc.)	4,5	4	4	4	5
Speeds and Feeds					
Definition and acronym for surface feet per minute	1	5	4	4	
Drilling – how the feed rate is designated	3	5	4	4	4
Applying the surface feet per minute formula to find rpm	3,7	4,5	4		4
Calculating cutting time	17,37	32	4		4-5
Calculating the feed rate for a milling operation	3,17,37	5,9,29	4-5		4-5
Calculating the rpm for a drilling operation	3,17,37	5,9,32	4-5		4
Math Applications					
Basic trigonometric applications	8,9,13, 41	4,5,6, 36	4-5		4-5
Value of Pi	37	32	4-5		4-5
Application of diagonals and diameters (largest or smallest square from round stock)	41		4		4
Metric conversion	35	31	3-4	4	4-5
Applications of formulas	37		4	4	4-5
Tolerance, Fits, and Allowances					
Converting inch tolerance to the metric equivalent	35	31	3-4	4	3
Understanding bilateral tolerancing	23	17	4	4	3
Allowance between mating parts for various types of fits	23,24	18	4-5	4-5	5
Assembly with a shrink fit	23,24	18	4-5	4-5	4

NIMS Job Planning, Benchwork, and Layout Theory and Performance Credentialing Exams	Jefferson College		ACT WorkKeys NCRC Skills and Levels		
	Learning Outcome	Course Outline	Workplace Documents	Graphic Literacy	Applied Math
Reaming					
Comparing the rpm for reaming and drilling	3	5	4	4	4
Stock allowance for machine reamers	3,4	5	4	4	
Identification of hand reamers	1	2	4	4	
Stock allowance for hand reamers	5	5	4	4	
Measurement (Semi-precision)					
Scale measurements to 1/100th of an inch	3,4,30	2,3	4	4	3
Combination set applications	3,4	2,3	4	4	4
Scale measurements to 1/64 th of an inch	2,3,30	3,4	4	4	3
Application of a plate protractor	5,6,41	4,5,36	4	4	4
Measurement (Precision)					
Divisions around a thimble on a micrometer	6,32	3	4	4	3-4
Solid square angularity	33		4	4	4-5
Reading a vernier scale on a caliper	31		4	4	4
Divisions on the spindle of a micrometer	6,32	3	4	4	3-4
Discrimination of a vernier caliper	31		4	4	4
Thread Terminology and Tapping					
Tap drill diameter	3,4,5	4,5,7	4	4	4
Basic thread terminology	3,4,5	4,5,7	4	4	4
Application of the three wire formula for checking threads	3,4,5	4,5,7	4	4	4
Types of taps in a tap set	3,4,5	4,5,7	4	4	4
Hole preparation for tapping	3,4,5	4,5,7	4	4	4
Importance of countersinking the hole to be tapped	3,4,5	4,5,7	4	4	4
Tool for removal of a broken tap	3,4,5	4,5,7	4	4	4
Basic tapping procedure and tap back-off rationale	3,4,5	4,5,7	4	4	4
Threads per inch on an inch micrometer	3,4,5	4,5,7	4		4

NIMS Job Planning, Benchwork, and Layout Theory and Performance Credentialing Exams	Jefferson College		ACT WorkKeys NCRC Skills and Levels		
	Learning Outcome	Course Outline	Workplace Documents	Graphic Literacy	Applied Math
Tap used to obtain maximum threads for a blind hole	3,4,5	4,5,7	4	4	4
Layout (Semi-precision)					
Layout instrument for layout of circles	5	2	4-5	4	4
Layout of angles with a combination set	5	2	4-5	4	4
Application of trammel points	5	2	4-5	4-5	4
Purpose and application of layout die	1,2,7	2	4-5	3-4	
Function of a scribe	6	2	4	3-4	
Layout (Precision)					
Precision layout tools used with a surface plate	5,6	2	4	4-5	4
Drilling					
Various drilling operations such as counterboring, countersinking, reaming, etc.	6	5	4	4	4
Drilling feed rate terms	3	5	4	4	
Calculating rpm for a drilling operation using the cutting speed formula	3	5	4-5	4-5	4-5
Included angle for countersinking a flat-head screw	9	5	4	4	4-5
Milling					
Climb milling and conventional milling characteristics	9	5	4-5		
Harder and softer materials and their correlation to cutting speed	2,3	5	4	4-5	
Milling a square from round stock	9	5	4-5		4
Milling feed rate calculations	3,4	5	5		4-5
Materials					
Materials and cutting speeds (relating to sfm and rpm)	2,3	9	4-5	4-5	
SAE steel identification system	1,10	9	4	5	

NIMS Job Planning, Benchwork, and Layout Theory and Performance Credentialing Exams	Jefferson College		ACT WorkKeys NCRC Skills and Levels		
	Learning Outcome	Course Outline	Workplace Documents	Graphic Literacy	Applied Math
Sawing					
Materials that can be cut with an abrasive cutoff saw	7	2	4-5	4-5	
Proper hacksawing procedures and strokes per minute	7	2	4	4-5	4
Filing					
Proper procedure and tool used to clean a file	3	2	4	4-5	
Filing to a layout line	3	2	4	4	
Post processing a surface after filing	3	2	4	4	
How to keep a file from loading up	3	2	4	3	
Blueprint Reading					
Types of lines used in print reading	20	10	4-5	5-6	
Functions of each type of line	20	10,11	4-5	5-6	
Surface finish symbols and interpretation	19		4-5	5-6	
Machine Theory					
Advantages of carbide-tipped cutters over high-speed steel	3	4,5	4-5	5	
Types of tools that produce holes (drills, saws, etc.)	7	7	4-5	5	
Knurling					
Definition of knurling	8	4	4-5	5	
Machine used for knurling operations	8	4	4-5	5	4
Performance Standard					
Benchwork					
Given a process plan, blueprint, access to hand tools, produce a part with two holes prepared for hand tapping, a hole prepared (reamed) for the press fit of a bushing, and a stud for one of the tapped holes.	5	2,3	4-5	5	
Deburr the part, hand drill and hand tap the holes, press in the bushing, and install the stud.	3,4	5	4-5		

NIMS Job Planning, Benchwork, and Layout Theory and Performance Credentialing Exams	Jefferson College		ACT WorkKeys NCRC Skills and Levels		
	Learning Outcome	Course Outline	Workplace Documents	Graphic Literacy	Applied Math
File chamfer.	5	2	4	4	
Layout					
Given a surface plate, surface gage, layout height gage, combination set, scribe, layout ink, prick punch, ball peen hammer, process plan, and part print, layout hole locations, radii, and surfaces matching the specifications.	5	2	4-5	5-6	

Measurement, Materials and Safety Curriculum Alignment to Textbook and WorkKeys

Precision Machining Technology Textbook	Jefferson College		ACT WorkKeys NCRC Skills and Levels		
	Learning Outcomes	Course Outline	Workplace Documents	Graphic Literacy	Applied Math
1. Introduction to Safety General Safety Guidelines Clothing for Machining Personal Protective Equipment Housekeeping Guards and Barriers Handling and Lifting Compressed Air Safety Lockout/Tagout Hazardous Materials SDS Fire Safety Safety Documentation	1,2	1	3-4	3	NA
2. Measurement Systems and Machine Tool Math Measurement Systems Machining Math Concepts and Operations	34,35	26-36	4-5	3-4	4-7
3. Semi-Precision Measurement Rules Calipers Adjustable Squares Angular Measurement Fixed Gages	5,7	3	4-5	4-5	NA
4. Precision Measurement Care of Precision Tools Straight Edges Precision Fixed Gauges Surface Plates	6	3	4-5	4-5	4-7

Precision Machining Technology Textbook	Jefferson College		ACT WorkKeys NCRC Skills and Levels		
	Learning Outcomes	Course Outline	Workplace Documents	Graphic Literacy	Applied Math
Solid Squares Gage Blocks Vernier Measuring Tools Micrometers Dial and Digital Measuring Tools Precision Transfer Measuring Tools Dial and Digital Indicators Sine Tools Surface Finish Measurement Optical Comparators Toolmaker's Microscope Coordinate Measuring Machine					
5. Quality Assurance, Process Planning, and Quality Control Quality Assurance The Process Plan Quality Control	28, 29	24	4-6	4-5	NA
6. Metal Composition and Classification Ferrous Metals Nonferrous Metals	1	4, 5	4-5	4-5	NA
7. Heat Treatment of Metals Hardening Tempering Annealing Normalizing Heat Treatment of Nonferrous Metals Heat-Treating Furnaces Heat-Treatment Safety Hardness Scales and Testing	1	4, 5	4-5	4-5	NA
8. Maintenance, Lubrication, and Cutting Fluid Maintenance Cutting Fluids	1,2	1,4,5	4-5	3	NA

Job Planning, Benchwork, and Layout Curriculum Alignment to Textbook and WorkKeys

Precision Machining Technology Textbook	Jefferson College		ACT WorkKeys NCRC Skills and Levels		
	Learning Outcomes	Course Outline	Workplace Documents	Graphic Literacy	Applied Math
1. Understanding Drawings Importance of Engineering Drawings Components of Engineering Drawings Basic Symbols and Notation Tolerance Classes of Fit Geometric Dimensioning and Tolerance (GD&T)	19,20,21,22,23,24, 25	10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25	4-5	4-5	4-5
2. Layout Layout Fluid Semi-Precision Layout Precision Layout Basic Layout Construction and Math Layout Procedures Guidelines	5,27,30,	2	4-5	4-6	5-7
3. HandTools Screwdrivers Pliers Hammers Wrenches Bench Vise Clamps Hacksaws Files Deburring Abrasives	1,2,3,4,5,6,7	1, 2,3	4-5	3	NA
4. Saws and Cutoff Machines Power Hacksaws Band Sawing Machines	7	2,3	4-5	3-4	4-5

Precision Machining Technology Textbook	Jefferson College		ACT WorkKeys NCRC Skills and Levels		
	Learning Outcomes	Course Outline	Workplace Documents	Graphic Literacy	Applied Math
Saw Blade Applications Band Saw Blade Welding Band Saw Blade Mounting/Removal Blade Speed The Abrasive Cutoff Saw Metal Cutting Circular Saws					
5. Offhand Grinding Grinder Uses Abrasive Belt/Disc Machine Uses Grinding Wheels Pedestal Grinder Setup Grinding Procedures	10	2	4-5	3	NA
6. Drilling, Threading, Tapping, and Reaming Benchwork Holemaking Operations Threading, and Tapping	4	4,5	4-5	4-6	4-5