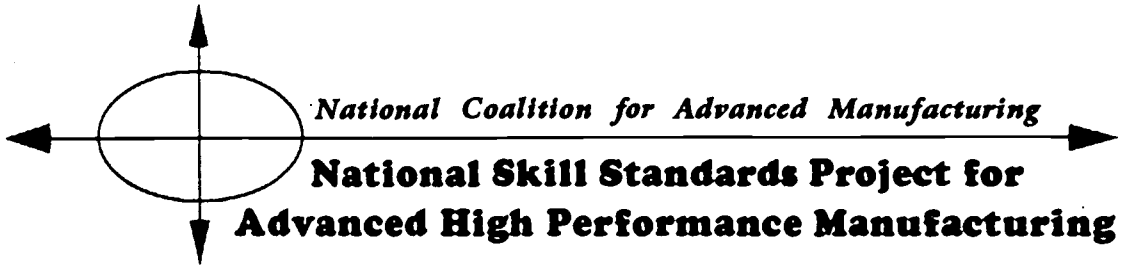
DOCUMENT RESUME

ED 406 577 CE 073 860

TITLE	National Skill Standards for Advanced High Performance Manufacturing. Version 2.1.
INSTITUTION	National Coalition for Advanced Manufacturing, Washington, DC.
SPONS AGENCY	Department of Education, Washington, DC.
PUB DATE	Apr 97
NOTE	68p.; Cover title includes: "What manufacturing workers need to know and be able to do..."
AVAILABLE FROM	National Coalition for Advanced Manufacturing, 1201 New York Avenue, Suite 700, Washington, DC 20005; telephone: 202-216-2742; fax: 202-289-7642; e-mail: cjshroll@aol.com ($39 members; $49 nonmembers; bulk rate available).
PUB TYPE	Reports - Research (143)
EDRS PRICE	MF01/PC03 Plus Postage.
DESCRIPTORS	Blueprints; Business Administration; Communication Skills; Competence; Competency Based Education; Computer Literacy; *Educational Needs; *Employment Qualifications; Instructional Development; Job Skills; Job Training; Manufacturing; *Manufacturing Industry; Mathematics Skills; Models; National Programs; Occupational Safety and Health; Personnel Management; Problem Solving; Program Development; *Skilled Occupations; Standards; Study Skills; Systems Approach; Teamwork; *Training Objectives; *Vocational Education
IDENTIFIERS	*High Performance Work Organizations; *National Standards; Quality Assurance

ABSTRACT

This document presents and discusses the national skill standards for advanced high-performance manufacturing that were developed during a project that was commissioned by the U.S. Department of Education. The introduction explains the need for national skill standards. Discussed in the next three sections are the following: benefits of national skills standards to educators, individual workers, students, parents, and other community members; scenario for using skill standards; and procedures for using skill standards for purposes of manufacturing process improvement, current employee training/development, new employee hiring, skills standards identification/development, job skill profile development, and skill match gap analysis. In the longest section of the document, the 210 national skill standards developed are listed by the following categories: communication and teamwork; math and measurement; workplace safety and health; problem solving; quality assurance; blueprint reading; manufacturing fundamentals; business planning and operation; computer use; process control and improvement; work force issues; workplace skills; and learning skills. Concluding the document are background information on the project to develop the standards and lists of the project committee members and individuals and organizations providing information/input during the standards' development. A skills standards framework is appended. (MN)



What manufacturing workers need to know and be able to do . . .

Version 2.1
April 1997

National Voluntary Skill Standards for Advanced High Performance Manufacturing

. . . and how to use them.

National Skill Standards for Advanced High Performance Manufacturing

C.J. Shroll, Project Director

A project conducted by

NACFAM
National Coalition for Advanced Manufacturing
Leo Reddy, President

for

The U.S. Department of Education

April 1997

NATIONAL SKILL STANDARDS FOR MANUFACTURING
1331 PENNSYLVANIA AVE NW • SUITE 1410 NORTH • WASHINGTON DC 20004-1703
VOICE: (202) 662-8968 • FAX (202) 662-8969 • INTERNET: CJSHROLL@AOL.COM
WORLD WIDE WEB HOME PAGE: HTTP://WWW.BMPCOE.ORG/NACFAM

For additional copies, contact:

The National Coalition for Advanced Manufacturing
1331 Pennsylvania Ave NW Suite 1410 North
Washington DC 20004-1703

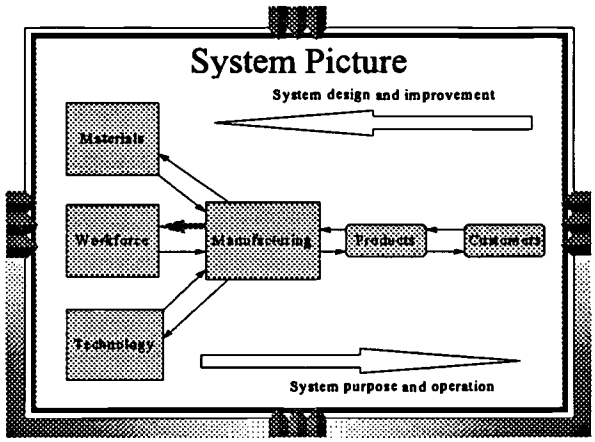
Telephone (202) 662-8960
Fax (202) 662-8964
e-mail: nacfam@explorer.clark.net
http:/www.bmpcoe.org/nacfam

Prices
NACFAM Members: $39.00; Non-members $49.00
Bulk rate (10 copies or more): 25% discount from above prices

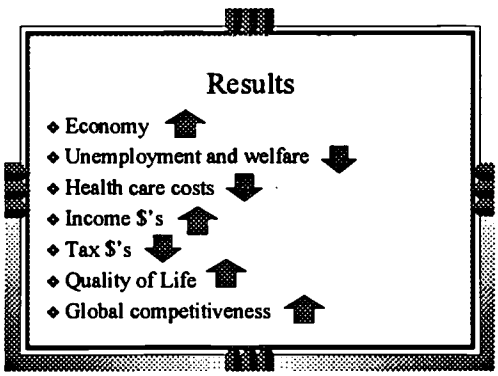
Table of Contents

Introduction

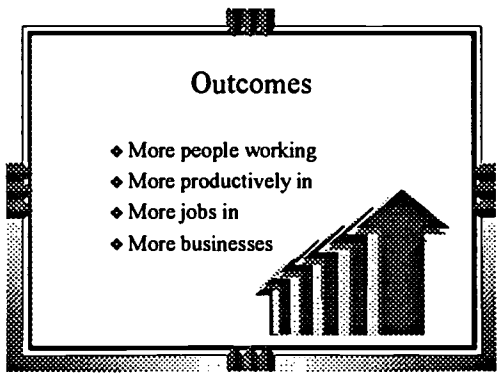
It is important to view this skill standards project in the proper context. While the project itself focused on the identification, development, and validation of skill standards for workers in advanced high performance manufacturing, this work was done in the context of a larger system improvement activity.



The broad system includes the relationship between all forms and phases of our education and training system in America and the world of work within which most citizens must be able to function successfully and gainfully.



The success measures of this broad system are the economy, the amount of unemployment and welfare, affordable and available health care, individual and collective income, tax rates, the quality of life resulting from a financially successful community, and the global competitiveness of individual companies. The skills and knowledge that an individual possesses, and their collective impact on companies and communities can be shown to affect all of the aforementioned measures.

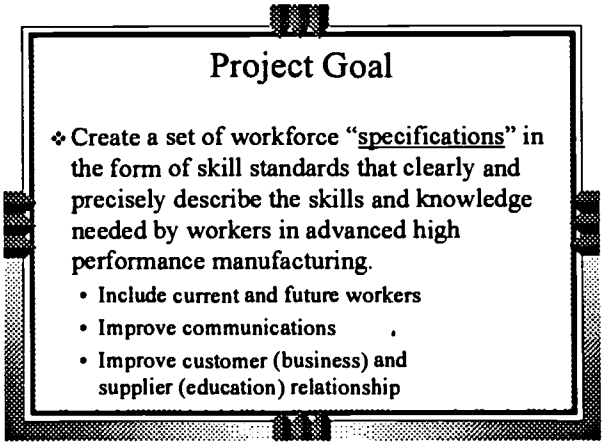


This project was formed and conducted to identify the skills and knowledge important to the workplace that result in continued and/or increased individual earnings and increased company success factors. There is a direct relationship between the success of individuals and

companies, and the success and quality of life experienced in communities. The changes that this project hopes to help facilitate are: more people working; more productively; in more jobs; provided by more businesses.

People are paid for what they can do, and what value they bring to a company. Skill standards identify the capabilities that are important, and therefore, valuable to employers. It is this relationship between manufacturing employers and employees, based on skill standards, that is the focus of this project. But, since this work was done within the broader system and context, many other entities were involved and will benefit from the results.

In addition to the identification and validation of skills, the project also identified, developed, and validated tools and methods for using skill standards for process and system improvement. It can be shown that skill standards, and systems for their use, are completely scalable and can work for one person and one job, for groups of jobs at a company, for companies across a community, and for communities across the country. And, at the same time, it can be shown that skill standards can be used by education and training activities, at the elementary through post-secondary levels, across communities, and by training activities for currently employed workers within or across companies. This usability, scalability and portability are critical elements of having a system that functions equally well at the individual, local or national level and can benefit all people, all companies, and all communities.



Using Skill Standards – The Vision

The goal of the project, and the broader effort supporting skill standards, is to create a tool set and methodology that can be used for improving the system of aligning the skills and knowledge of current and new workers with the current and future needs of the workplace. This requires better communication between employers, workers, educators and trainers, students, community members and leaders, and parents. Skill standards can help improve communication among all of these groups.

Skill Standards - a communication tool to:

- Specify the skills and knowledge required for a job
- Detail the skills and knowledge a person has
- Help identify the match or gap
- Help focus learning activities
- Help people get their first, new, or better job

Skill standards are about people and jobs. Skill standards accurately and effectively specify the skills and knowledge people need in order to successfully and effectively perform a manufacturing job. It is this ability to successfully accomplish work of value to employers that is the basis for the financial agreement between employers and employees. People get paid for *what they can do.* Employers need, and are willing to pay for, people who have the skills and knowledge to perform the work of the business. The more an employee can deliver what is of value to the employer, the more she or he will get paid. This addresses the relationship between skills and wages.

The total list of skill standards developed by this project is inclusive of many different jobs and employers in advanced high performance manufacturing. Any one job may only take a subset of the skill standards while other jobs may require additional skills. However, since these skill standards do represent a broad national picture, and are equal to or surpass global standards, they serve as an excellent starting point and benchmark for company specific or community wide system and process improvement.

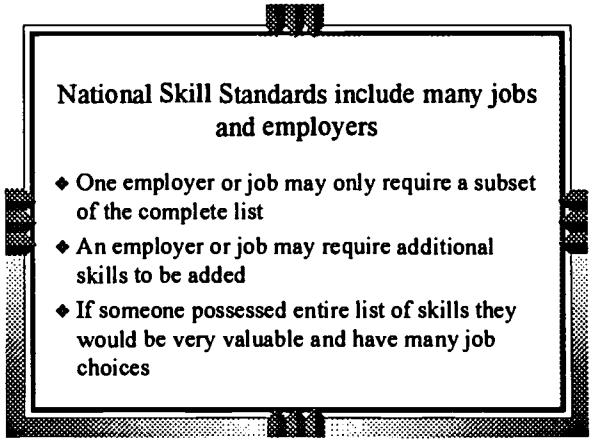
By having a comprehensive and standard list, a taxonomy of skills, from which to select, employers will be able to more clearly and consistently state

their skill and knowledge requirements: their workforce specifications. This common set of skills, used by many different employers will make it much easier for workers, students, teachers, and others to identify the skill requirements of a specific employer or the common skills required by many different employers in a given area.

In addition to employers:

- Educators need the list of skill standards to ensure alignment between the curriculum and learning activities they provide for students and the needs of the workplace, either generally or specifically.
- Individual workers can use the skill standards to accurately identify their current skills, and then determine learning goals for themselves that will enable them to improve their performance and build employment security.
- Students will be able to more clearly see employer standards for specific jobs and wages, and therefore, will more easily understand the requirements of the workplace towards which their learning activities are being directed.
- Parents and other community members will be able to better recognize the success schools are having at preparing students for the work they will eventually enter, by comparing student accomplishments against employer benchmarks.

Advanced manufacturing employers can customize the standards to their own situation by selecting those skills from the skill standards list required for their particular company and/or job. This would create a job/company specific profile. An individual can use the list of skill standards to identify the skills they possess, thereby creating as personal skill profile. The comparison of these two profiles will clearly show the matches and gaps between company skill standards and the worker or applicant's skill inventory.

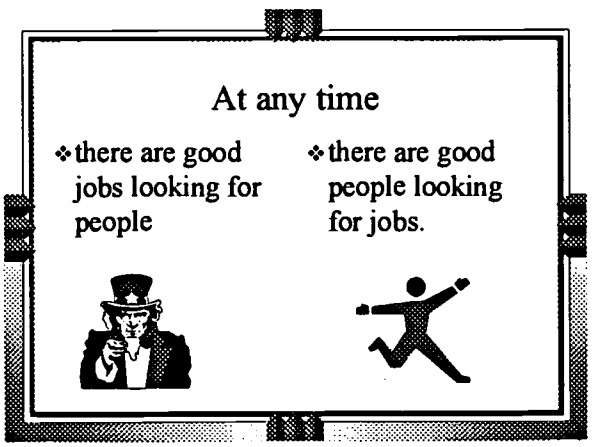


Using Skill Standards – a scenario...

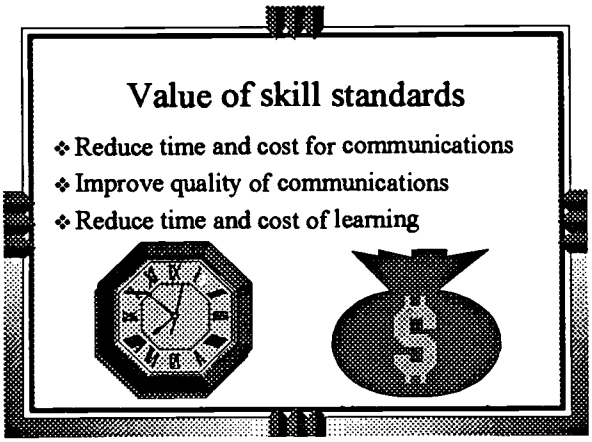
In a given community working with several manufacturing companies, data on workplace skills requirements are gathered, validated, benchmarked, and transformed into information which can then be communicated effectively to providers (schools) and other stakeholders and participants in the system. This information is based on the discrete input gathered from currently successful workers in the various companies. The resulting database of skills will allow for the continual identification of the requirements of specific companies, but will also show which skill requirements are common to several or all companies.

Those that are common to all companies should be included ubiquitously throughout the community's schools in the early years since all students will eventually need these skills in the workplace. Those skills that are unique to a subset of prospective employers would be included later in the school curriculum. Those skills that are very specific and unique may be the subject of specialized learning activities or may be provided by the employer after employment.

From a different perspective, skill standards-based information will be used to develop company-specific skill and knowledge profiles. Such a company will then use the profile of important skills to identify employee skill profiles. By comparing the ideal profile with aggregate and individual employee profiles, both the company and individual employee(s) will be able to identify the opportunities and need for employee development. If this process is implemented on a continuous basis, the company will be demonstrating the hallmark practice of high performance companies. High performance companies have been shown to have the greatest potential for short and long term success. This process can be used for both current and future workers.



With this information clearly and specifically identified, companies can use skill standards to communicate more effectively to training providers and community schools, the skills and knowledge that employees need to learn. Documentation of skills learned will form a far superior basis for contractual agreements and success evaluations than the current "seat-time" measures.



Likewise, employers using their company-specific profiles will begin to advertise based on skills and knowledge needed. This will be a significant and welcome improvement to the current form of most job descriptions and job title based ads. Potential applicants can then more easily and accurately compare their own skill profiles with a company's current need. This will enable the portability of skills and break through the barrier of "no experience" in a particular job title. This improved system of ads and responses will greatly reduce the cost to employers and the anguish of applicants by minimizing the screening of applicants and assessing work readiness by temporary work assignments. It will also reduce the number of new-hires that "do not work out" because of different expectations and unfounded assumptions.

At the community level, the aggregate of a number of company specific profiles, undergirded by the national information, will give a more clear direction to the schools, students and parents about the learning that should be taking place in the community's schools. Schools can use this information to focus curriculum and design appropriate learning activities. The attainment of skill standards is totally consistent with either a vocational, general, or college track program. By utilizing clear and specific skill standards as a foundation for curriculum and learning, schools will be better able to document student achievement relative to the world of work.

At the same time, students and parents will be able to use skill standards to more clearly identify the success of schools. The success of a community's schools has a direct impact on the future success of the citizens and businesses of that community. For communities to be successful, and for all citizens to experience a desirable quality of life, schools, companies and workers must be successful. This success can only be achieved if there is precise alignment between the skills that employers need and the skills that employees possess, regardless of the level or scope of the job.

Full implementation of a skill standards based system will help participants and stakeholders meet their individual goals. Companies will use their measures of cost, quality and schedule. Students will see greater job opportunities offering higher wages. Schools will better be able to document the learning they are helping students to accomplish. Communities will see greater economic growth, higher standards of living, reduced unemployment, and reduced social costs.

The existence of effective systems of workforce preparation in a community or region is also critical to the attraction of new and expanding businesses to the area. It can be shown that workforce skills are one of the most important factor affecting a business' decision to locate, remain, or expand in a community. Businesses cannot function successfully and profitably without employees who are able to perform well in their job. This is true of any business.

The community must implement such a workforce skills system aggressively, and continuously improve the processes. This is critical if the community is to realize the maximum potential benefits. Equally, and perhaps more importantly, communities must strive to remain competitive with other regions of the country and world who already implementing and using such systems. There is clear evidence that the full development and implementation of such a system will benefit students, adult learners, current employees, schools, communities, parents, companies, and the community's quality of life.

Using Skill Standards
Tools, Methods and Sample Products

Manufacturing Process Improvement

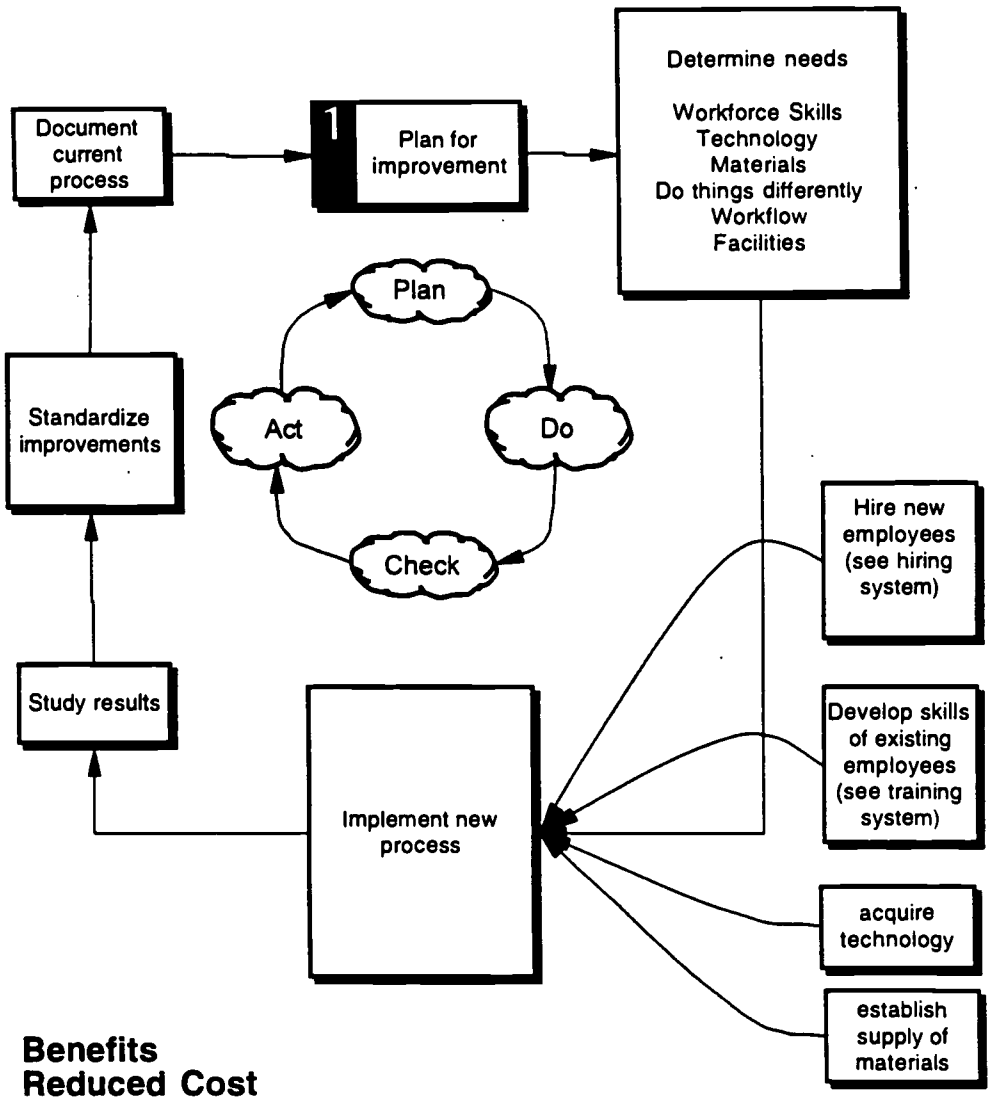
This first process picture depicts the overall manufacturing process improvement cycle including the "plan, do, check, act" cycle widely used in business process improvement today. It shows the expected benefits of: Reduced Cost, Reduced Time, and Increased Customer Satisfaction. It is critical to establish this context for the inclusion of skill standards, and to demonstrate that they can, and must, be an integral part of all manufacturing improvement activities.

The first step of the process is to recognize the need, and plan for improvement. This assumes that data has been collected from the existing process that quantifies cost, time, and customer satisfaction. Included in customer satisfaction is the element of schedule and on-time delivery. The process improvement team will suggest improvements in processes, materials, technology, and, most importantly, workforce skills. Unfortunately, identification of workforce skills has too often been omitted in the past. However, with the advent of skill standards, and sub-systems to facilitate their identification and implementation, it will now be much easier to include workforce skills at this critical first step.

Represented on this chart are the most typical and frequent inputs to the manufacturing process. It also includes the potential of both upgrading the skills of the existing workforce and the hiring of new workers. Following this process chart is one specifically dealing with current workers and one specifically dealing with new workers.

As in any good process improvement picture, the need to study results and standardize practice is clearly documented. It is at this point that the value of skill standards, in conjunction with other elements, can be measured, documented, and used as the basis for future and further improvements as the improvement cycle is repeated continuously.

Manufacturing Process Improvement System



Benefits
Reduced Cost
Reduced Time
Increased Customer Satisfaction

Using Skill Standards - Current Employee Development Process

This process picture is focused on the use of skill standards applied to the development of current workers. Viewing should start at the step depicting the manufacturing process improvement covered in the previous chart.

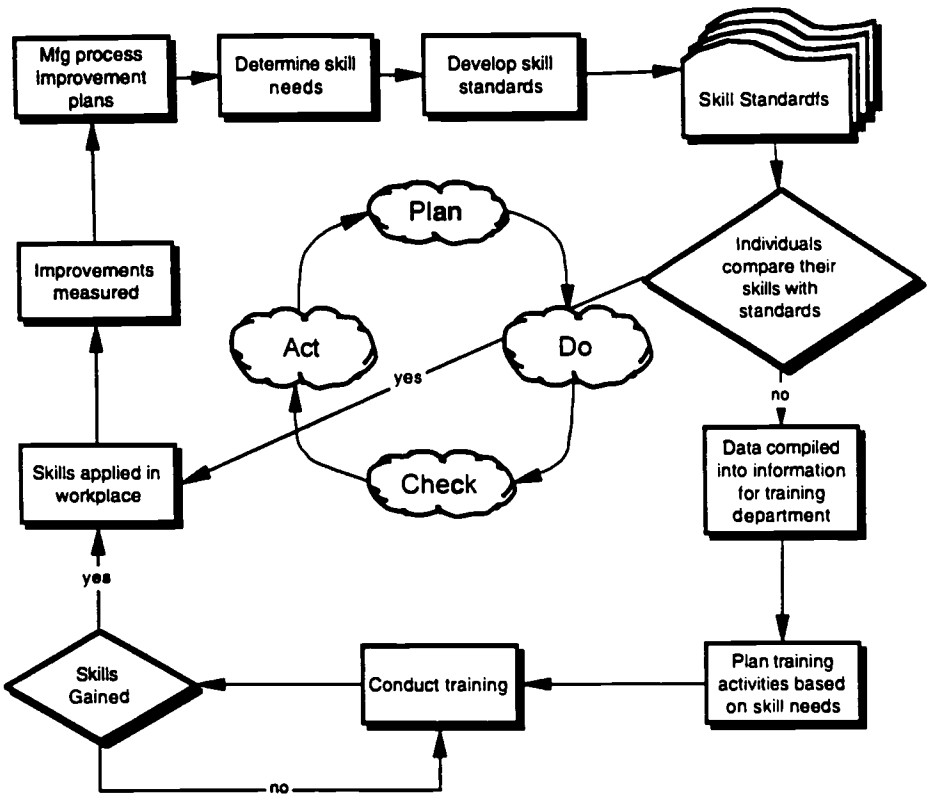
The three boxes across the top represent the steps involved in actually determining the skill standards. A later chart will describe the sub-process for identifying the skill standards. This chart covers use of identified skill standards. This follows the current best practice of macro to micro (top down) planning followed by micro to macro (bottom up) implementation.

After the skill standards have been identified, the skill profiles of current workers are developed and compared to the newly developed job skill profile. If workers have the requisite skills, they can be immediately applied to improve the process. If there is a gap between the job skill profile and worker skill profile, then this information can be used by the workers themselves and/or the training facilitator to identify learning opportunities to close the skills gap. The chart then depicts that training takes place. This may be in the form of classroom training on site, or at a community college. It may also be in the form of on-the-job-training; learning from other workers who already have the needed skills.

A very important step is the decision point that determines whether the skills have been gained. This is the correct indicator of when the training/learning is complete, not the quantity of "seat-time" in training sessions. Workers can only apply skills to the process if they have become proficient in those skills. It is of no value to have attended "40 hours of training," but still be unable to perform the work.

The process includes the critical steps of measuring improvements and standardizing. This data can then be used for improving the training/learning process as well as the next cycle of improvement of the manufacturing process. This chart depicts the improvement indicators applied to this sub-process: employee satisfaction, workforce flexibility, productivity, reduced extra cost, and contribution to continuous improvement.

Skill Standards-Based Manufacturing Employee Training Process



Benefits

- **Happier employees**
- **Greater workforce flexibility**
- **Greater productivity**
- **Less overall time and unit cost**
- **More flexible budgets**
- **Supports process improvement**

Using Skill Standards – New Employee Hiring Process

The process chart on the next page depicts the use of skill standards applied to the hiring of new workers and includes the critical communication to the community, its people and its schools.

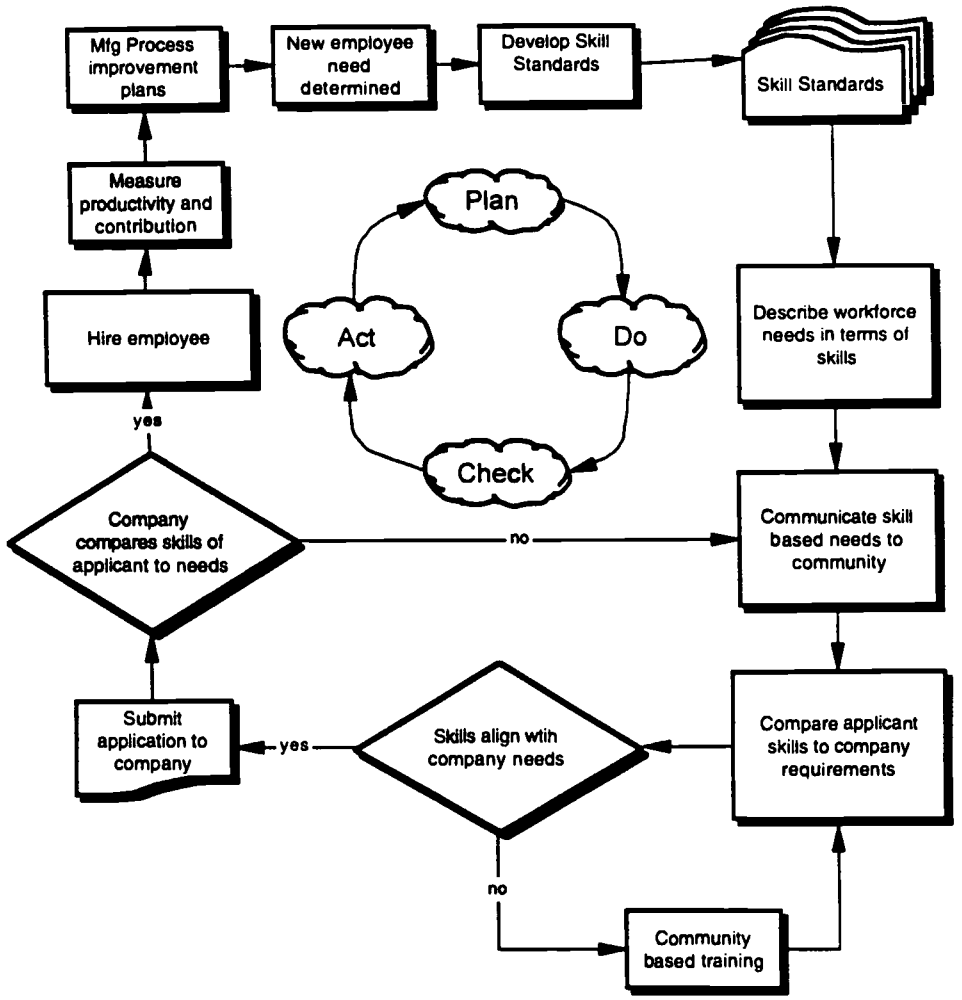
Once again the skill requirements are determined as part of the business process planning activity. This ensures that the skills identified are essential and valuable to the business process. Therefore, companies will be able to identify and communicate these skill needs to the community.

The next step is for an applicant or student to compare his or her own skills to those needed by the business process. If there is a match, then the individual could choose to submit an application to the company based on matching skill profiles. If there is a gap, the applicant or student could find the appropriate community training resource to gain the needed skills. This use of existing community resources is a much better situation than that now encountered by many employers who have no option other than hiring people without needed skills and then providing the training themselves.

If the alignment between needed skills and applicant skills is confirmed, then the person can be hired with a much greater assurance of success on the job. The next step once again measures productivity and contribution. This provides data that can be fed back to the hiring process and community education and training system for their respective improvement.

The success indicators for this process are: reduced staff time and cost for interview and selection; more and better qualified applicants; improved productivity due to reduced learning on the job; less time consumed communicating with schools; and a greater number of job opportunities for individuals.

Skill Standards Based Hiring Process



Benefits

Less staff time for interview and selection
Attract more and more qualified applicants
Improved productivity due to less OJT
Better communication to community schools
More opportunity for individuals

Using Skill Standards – Identification & Development Sub-System

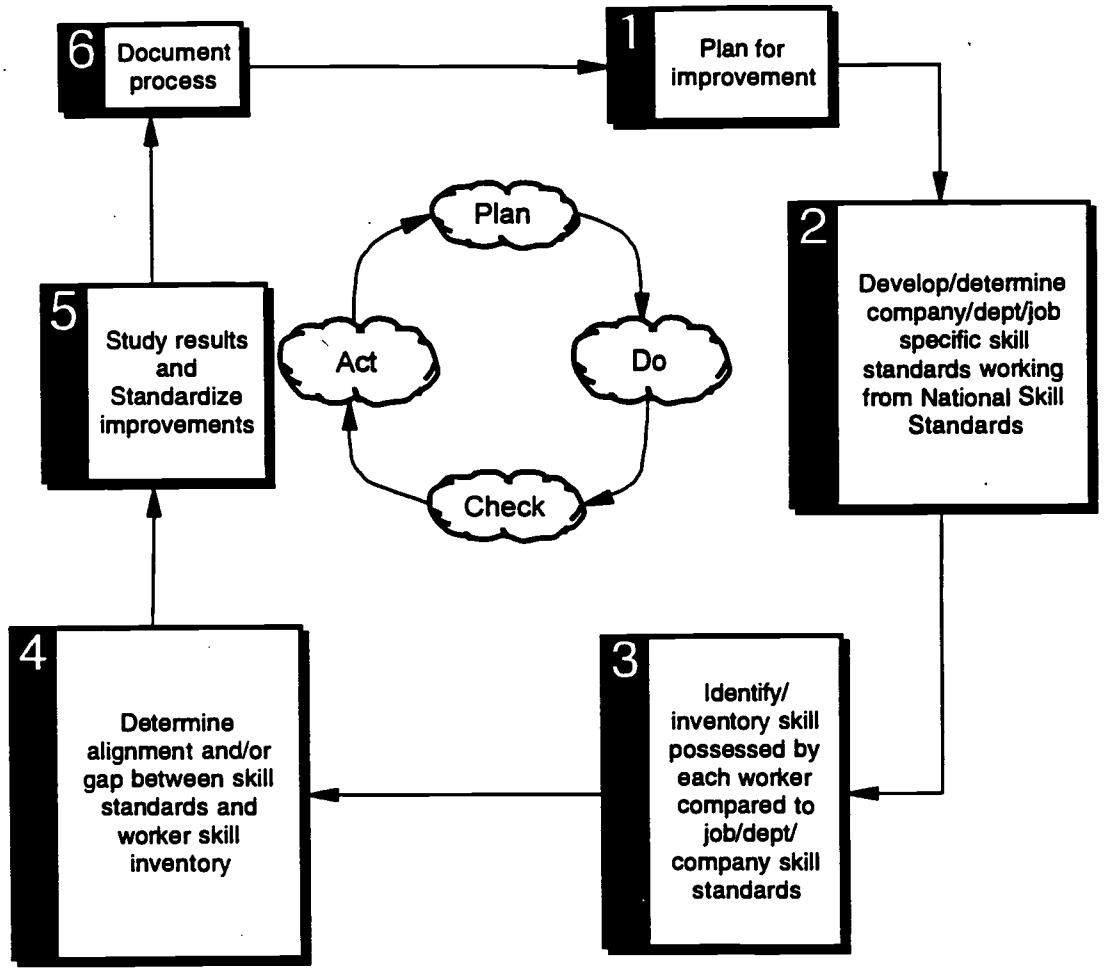
This next process picture depicts the process for specifically identifying the skill standards for a job or company. Examples of the tools used in this process follow the chart on the opposite page.

As part of the plan for process implementation or improvement, skill needs can be identified working from the taxonomy of skill standards for manufacturing that has been developed. Process performers (workers) and process owners in the company can select the requisite skills. Tailoring the national standards to a specific company provides a solid foundation for workforce skills development and process improvement. Working from the national skill standards helps to avoid the "blank sheet of paper" syndrome.

This process works best by first dealing with the list of skills and then moving to the skill standards. The list of skills may be very similar across companies. The principal differentiation between companies occurs when standards are developed for each skill. In addition to providing taxonomy from which to select, the national standards add additional value since they provide comparative benchmark and best-practice information.

The use of the resulting skill standards for the company or job has been covered in previous descriptions.

Develop Skill Standards Sub-System



Using Skill Standards - Job Skill Profile

The example on the opposite page is based on a real-world example of necessary skills identified across various departments in a company. The picture works equally well for multiple departments of a company, or multiple companies of a community. A single company or job would only have a single column.

Current workforce members identify the skills that are important. The example demonstrates the possible variation of skills required in different departments or companies. The unique information about skills required in a single department or company would be compared with an individual's profile. This would show and document the skills match or gap.

Using Skill Standards - Individual Skill Profile

This example shows how individual skill profile information might be collected. The list of skills presented to an individual could either be just those for a particular job or a comprehensive set of skills across several departments or companies. Computer database programs make the appropriate comparisons easy to make.

The definitions of the different levels of proficiency are as follows:
Aware – this means that you have heard about this skill and recognize its importance in the workplace. You have been exposed to this skill or knowledge by reading, listening or observing.
Know – at this level you can explain this skill, and its importance, to someone else. You can recall the information about the skill or knowledge. You can make some use of the skill or knowledge in the workplace.
Perform – selecting this choice means you can use the skill at the required level in the workplace. You also have the ability to use the ideas, methods, concepts, principles, and theories in new situations.
Need training – select this box if you have an immediate need or desire to be involved in training to improve this particular skill and/or knowledge.

Company (or Departmant) Job Skill Profiles

		Skill Required					
		A	B	C	D	E	F
MM24 Skill	Distinguish between general and precision measurement.	Y	Y	N	Y	Y	Y
Skill Standard	Accurately select from a list of 15 examples, those practices or situations that are classified as either general or precision measurement activities.						
MM25 Skill	Distinguish between US and metric measurement systems.	Y	Y	N	N	Y	Y
Skill Standard	A person working in manufacturing may be faced with either US or metric measurements, either at different companies or in the same company. Therefore, a person must be able to distinguish between US and metric systems. This would be demonstrated in a structured learning experience, or on a previous job. This should be done with complete accuracy.						
WORKPLACE SAFETY AND HEALTH							
WH 1 Skill	Assume responsibility for the personal safety of self and others.	Y	Y	Y	Y	Y	Y
Skill Standard	In a situation with health or safety risks, a person with this skill will take and implement all appropriate personal safety precautions such as hard hats, eye protection, protective clothing or protective footwear. A fully competent worker will also insist that other co-workers take similar precautions. Being able to explain to others the reasons for safety, including personal protection and the effect on company finances and health care costs are essential.						
WH 2 Skill	Maintain a clean and safe work environment.	Y	Y	Y	Y	Y	Y
Skill Standard	In order to protect personal safety and maximize productivity, it is important to maintain a clean and safe work environment. A person could demonstrate this skill in a work environment, in an avocational endeavor, or in a training learning situation. Proper demonstration of this skill could be documented by a co-worker, supervisor, instructor/trainer, or self.						
WH 3 Skill	Demonstrate a positive personal attitude towards safety.	Y	Y	Y	Y	Y	Y
Skill Standard	In order to fit in successfully in a high performance workplace where personal safety is an essential part of workplace practice, a good worker must demonstrate a positive personal attitude towards safety of self and company property. This means the person would always practice proper safety and would react with positive comments, tone of voice, and body language as part of any discussion on safety issues or practices.						

Determining Individual Skill Profile

		Aware	Know	Perform	Need Training
MM24 Skill	Distinguish between general and precision measurement.	☐	☐	☐	☐
Skill Standard	Accurately select from a list of 15 examples, those practices or situations that are classified as either general or precision measurement activities.				
MM25 Skill	Distinguish between US and metric measurement systems.	☐	☐	☐	☐
Skill Standard	A person working in manufacturing may be faced with either US or metric measurements, either at different companies or in the same company. Therefore, a person must be able to distinguish between US and metric systems. This would be demonstrated in a structured learning experience, or on a previous job. This should be done with complete accuracy.				
WORKPLACE SAFETY AND HEALTH					
WH 1 Skill	Assume responsibility for the personal safety of self and others.	☐	☐	☐	☐
Skill Standard	In a situation with health or safety risks, a person with this skill will take and implement all appropriate personal safety precautions such as hard hats, eye protection, protective clothing or protective footwear. A fully competent worker will also insist that other co-workers take similar precautions. Being able to explain to others the reasons for safety, including personal protection and the effect on company finances and health care costs are essential.				
WH 2 Skill	Maintain a clean and safe work environment.	☐	☐	☐	☐
Skill Standard	In order to protect personal safety and maximize productivity, it is important to maintain a clean and safe work environment. A person could demonstrate this skill in a work environment, in an avocational endeavor, or in a training learning situation. Proper demonstration of this skill could be documented by a co-worker, supervisor, instructor/trainer, or self.				

Using Skill Standards – Match Gap Analysis Example

The example on the facing page is drawn from an actual situation and provides a "picture" of how current workers might respond to this type of process. The data comes from current workers and points out areas for individual improvement and at the same time provides direction to the training department about what opportunities for learning ought to be provided.

While this example is a compilation of multiple workers, an individual profile would be just a check in the appropriate box. This example is a sum of the checks in the boxes for several individuals.

Aggregate of Individual Skill Profiles

		Aware	Know	Perform	Need Training
MM24 Skill	Distinguish between general and precision measurement.	3	4	29	3
Skill Standard	Accurately select from a list of 15 examples, those practices or situations that are classified as either general or precision measurement activities.				
MM25 Skill	Distinguish between US and metric measurement systems.	3	10	29	5
Skill Standard	A person working in manufacturing may be faced with either US or metric measurements, either at different companies or in the same company. Therefore, a person must be able to distinguish between US and metric systems. This would be demonstrated in a structured learning experience, or on a previous job. This should be done with complete accuracy.				
WORKPLACE SAFETY AND HEALTH					
WH 1 Skill	Assume responsibility for the personal safety of self and others.	6	9	29	3
Skill Standard	In a situation with health or safety risks, a person with this skill will take and implement all appropriate personal safety precautions such as hard hats, eye protection, protective clothing or protective footwear. A fully competent worker will also insist that other co-workers take similar precautions. Being able to explain to others the reasons for safety, including personal protection and the effect on company finances and health care costs are essential.				
WH 2 Skill	Maintain a clean and safe work environment.	2	10	32	.2
Skill Standard	In order to protect personal safety and maximize productivity, it is important to maintain a clean and safe work environment. A person could demonstrate this skill in a work environment, in an avocational endeavor, or in a training learning situation. Proper demonstration of this skill could be documented by a co-worker, supervisor, instructor/trainer, or self.				
WH 3 Skill	Demonstrate a positive personal attitude towards safety.	4	8	30	5
Skill Standard	In order to fit in successfully in a high performance workplace where personal safety is an essential part of workplace practice, a good worker must demonstrate a positive personal attitude towards safety of self and company property. This means the person would always practice proper safety and would react with positive comments, tone of voice, and body language as part of any discussion on safety issues or practices.				
WH 4 Skill	Comply with established safety practices.	3	8	31	3
Skill Standard	The individual or team will comply established safety practices, 100% of the time on a ongoing basis. To be documented by written tests and third party observations.				
WH 5 Skill	Complete forms/paperwork as required.	4	12	29	2
Skill Standard	It is important to the operation of a company that required forms and paperwork are completed on time and contain all requested information. The information should be spelled correctly and be legible. The skill could be documented from previous work experience or a structured learning experience.				
WH 6 Skill	Wear protective safety clothing as required.	1	8	29	1
Skill Standard	Individual should demonstrate proper selection and use of protective safety clothing appropriate to the manufacturing environment.				
WH 7 Skill	Maintain and use protective guards and equipment and machinery.	2	13	28	4
Skill Standard	The individual or team will maintain and use industry or company-specified protective guards on equipment and machinery, performing all specified procedures prior to equipment operation with 100% accuracy. To be documented with a checklist by third party observation.				
WH 8 Skill	Handle/store flammable (hazardous) materials appropriately.	3	8	32	4
Skill Standard	The individual will handle and/or store flammable (hazardous) materials appropriately, correctly handling and storing five flammable materials with 100% accuracy. To be documented by third party observation.				
WH 9 Skill	Use electrical devices correctly and safely.	5	10	29	2
Skill Standard	Identify electrical devices and state how incorrect use can be hazardous				

The Skill Standards for Advanced High Performance Manufacturing

What manufacturing workers need to know and be able to do.

The following skill and knowledge statements and standards represent what we have determined to be important to manufacturing firms. The list has been compiled from high-performance manufacturing workers, managers, owners, and educators. This list has been identified and developed by industry representatives and represents the skills and knowledge that industry needs of its workforce. Possession of these skills will make it possible for an individual to be very successful in a variety of manufacturing occupations.

What is a skill standard?

- A statement that specifies the level of knowledge and competency required to successfully perform work related functions

Each of the skill statements should be read as a completion of the statement; "A good competent skilled worker can..."

Each of the skill standards represents an expansion of the skill statement to include the conditions, context, criteria, and forms of documentation as deemed appropriate by those providing input to the project.

Communication and Teamwork

CT 1 Skill ***Identify interpersonal characteristics of a team player.***

Skill Standard The individual will identify the interpersonal characteristics of a team player, listing 10 characteristics of a team player with 100% accuracy. To be documented by a third party observation or a written skills activity.

CT 2 Skill ***Demonstrate the characteristics of a team player.***

Skill Standard The individual will demonstrate the characteristics of a team player, displaying ten characteristics over a reasonable period of time in an ongoing evaluation. To be documented by a third party observation.

CT 3 Skill ***Contrast the role of a team with the role of an individual.***

Skill Standard The individual will contrast the role of a team with the role of an individual, by listing ten characteristics of a team that contrast with those of individuals, within thirty minutes with 100% accuracy. To be documented by a third party observation or written performance assessment.

CT 4 Skill ***Perform techniques used as a team leader.***

Skill Standard In a team environment, identify techniques used by a team leader and demonstrate them.

CT 5 Skill ***Demonstrate productive relationships within the work group.***

Skill Standard Demonstrate positive participation in group activities by receiving confirmation from other group members that the participation has been productive and without conflict.

CT 6 Skill ***Apply group dynamic principles to manufacturing situations.***

Skill Standard Functioning as a group leader, and applying positive group dynamics, develop a plan for improving a simple manufacturing process.

CT 7 Skill ***Identify possible electronic communication uses.***

Skill Standard In either written or oral form, provide at least three situations where electronic communication such as e-mail would be an advantage.

CT 8 Skill ***Explain the effect of electronic communication versus other communications methods.***

Skill Standard Explain the effect of electronic communication versus other communications methods. The explanation should be provided orally and include at least three specific comparisons and a recommendation of the best method for three different situations.

CT 9 Skill ***Select appropriate communication methods.***

Skill Standard The individual or team will select appropriate communication methods, convey the message via the chosen method and achieve 100% accuracy in the third party understanding the message. To be documented by third party observation and comprehension of the intended message.

CT10 Skill ***List the characteristics of a good group leader.***

Skill Standard Working alone or in a group, an individual must identify and demonstrate through role play 6 of the 8 desired characteristics that an individual must possess in order to be a good group leader.

CT11 Skill ***Identify various group processes.***

Skill Standard After having participated in workplace specific teamwork training, select from a list at least 6 appropriate processes for a group.

CT12 Skill Identify components of group dynamics.

Skill Standard After having participated in a workplace specific teamwork training activity, provide a list of at least 5 important skills and processes that lead to successful and productive teamwork.

CT13 Skill Demonstrate group leadership.

Skill Standard In order for an individual to effectively manage and lead meetings in a team environment, the individual must be able to demonstrate group leadership skills. These leadership skills include preparing a meeting agenda, planning/organization, keeping the meeting focused and on track, delegating tasks and responsibilities, encouraging participation, time management, providing positive feedback and group facilitation. The individual will conduct a meeting demonstrating 5 of the 8 group leadership skills.

CT14 Skill Apply facilitation skills in a group setting.

Skill Standard In a manufacturing or learning environment, receive positive affirmation from other group members and/or instructor that at least 4 specific facilitation techniques were correctly and productively applied.

CT15 Skill Read process information and follow instructions.

Skill Standard Demonstrate the ability to read a 50-word description of a three-step assembly process and the ability to follow the instructions so that the assembly is completed according to the instructions.

CT16 Skill Read material and describe concepts.

Skill Standard The individual must be able to read, interpret and summarize in writing the fundamental concept contained within each paragraph of reading material with 100% accuracy.

CT17 Skill Read documentation, such as a computer manual, to determine actions for specific situations.

Skill Standard Demonstrate the ability to read documentation, such as a computer manual, to determine actions for specific situations. This could be demonstrated by finding the instructions in a provided manual about underlining selected text and properly perform underlining activity.

CT18 Skill Write the steps of a manufacturing process using sentences and statements as appropriate.

Skill Standard Working as a member of a team, write out in complete sentences with pen and paper or on the computer, the steps involved in a specific area of the manufacturing process, with 100% accuracy, in order to demonstrate the ability to identify, in writing, the sequence of and interconnectivity between the steps in the process. This would be done correctly if three other people not previously with the process were able to perform it correctly.

CT19 Skill Use correct punctuation.

Skill Standard Working alone, use correct punctuation, such as commas to separate items, periods to separate thoughts, apostrophes to show possession, exclamation points to show

emphasis, semicolons and colons to separate phrases, with 100% accuracy; in order to illustrate a standard interpretation of what is intended. To be documented by an employer, instructor, or team member.

CT20 Skill Use correct spelling.

Skill Standard Working alone, use correct spelling with 100% accuracy, in order to demonstrate proficiency in writing clear and understandable written communications. To be documented by an employer, instructor, or team member.

CT21 Skill Write with accuracy, brevity and clarity.

Skill Standard The individual will write with accuracy, brevity and clarity three documents and deliver those documents to a third party, and the messages are understood with 100% accuracy. To be documented by third party receiving and understanding the documents.

CT22 Skill Organize material with a logical flow.

Skill Standard Demonstrate the ability to organize a series of five steps in a given process into the proper logical order such that the process is logical for a manufacturing assembly process.

CT23 Skill Organize and deliver a persuasive oral presentation.

Skill Standard An individual or team will organize the appropriate resources or research necessary to deliver a persuasive oral presentation, in order to illustrate the importance of oral communication in solving problems or making decisions. The presentation will be evaluated by a third party.

CT24 Skill Demonstrate good speaking characteristics.

Skill Standard The individual will demonstrate good speaking characteristics in order to converse in a professional and socially acceptable manner. Individuals will show appropriate use of grammar, context and style in a 10-20 minute business conversation and evaluated by the second party.

CT25 Skill Demonstrate appropriate presentation demeanor.

Skill Standard The individual or team will demonstrate appropriate skills and techniques necessary to deliver a business presentation, in order to illustrate the importance of oral communications in problem solving, decision making or sharing of information. The presentation will be evaluated by a third party. Examples of appropriate demeanor are dress, voice tone and volume, eye contact, organization, gestures etc.

CT26 Skill Interpret and clarify directions prepared by others.

Skill Standard The individual or team will interpret and clarify directions prepared by others. Given three sets of directions, the individual or team will perform the specified tasks within a reasonable timeframe with 100% accuracy. To be documented by third party observation of the skills performance.

CT27 Skill Communicate with customer to establish requirements.

Skill Standard The individual will communicate with the customer to establish requirements. Given two role-plays or actual situations, the individual will identify those needs and fully satisfy the customer with 100% accuracy. To be documented by third party observation of the skills performance.

Math and Measurement

MM 1 Skill Add, subtract, multiply and divide four digit numbers with the use of a calculator.

Skill Standard Working alone with a calculator, add 10 three or four-digit numbers five times in three minutes with 100% accuracy, in order to perform necessary calculations for SPC (Statistical Process Control) during the manufacturing process. To be documented by third party or performance assessment.

MM 2 Skill Add, subtract, multiply, and divide four digit numbers without the use of a calculator.

Skill Standard Working alone without a calculator, add 10 three or four-digit numbers five times in three minutes with 100% accuracy, in order to perform necessary calculations for SPC (Statistical Process Control) during the manufacturing process. To be documented by third party or performance assessment.

MM 3 Skill Apply basic math function to solve problems.

Skill Standard Given a common manufacturing situation such as the need to calculate the total cost of an assembly and the cost of each of several component parts, demonstrate the use of basic math functions to compute the answer.

MM 4 Skill Create and interpret basic graphs and charts commonly used in manufacturing.

Skill Standard Demonstrate the ability to describe the meaning and importance of each of 5 common charts used in manufacturing such as those showing SPC data, customer satisfaction, number of lost time accidents, percentage of products meeting quality requirements, and number of inventory turns.

MM 5 Skill Match measurement activities to manufacturing process.

Skill Standard Given three common manufacturing situations requiring the measurement of component or assembled parts, select the proper measuring device such as micrometer, vernier caliper, steel tape or rule, thread gage.

MM 6 Skill Select and use appropriate measurement techniques and instruments.

Skill Standard Complete MM5 and then demonstrate the use of the various measurement devices according to commonly accepted industry standards and/or instructions for proper use provided by the manufacturer of the measuring device.

MM 7 Skill Describe measurements' role in manufacturing.

Skill Standard Provide a 100-word description of the importance of measurement in manufacturing. Should include reference to fit, function, and customer requirements.

MM 8 Skill Distinguish between direct and calculated measurements.

Skill Standard Given appropriate part prints, show which measurements may be made or used that are directly applied to the part, and those which are or must be calculated by adding component dimensions. Ideally this would also include a description of the potential error introduced by doing "chain" measurements.

MM 9 Skill Compute calculated measurements.

Skill Standard Demonstrate the ability to add and subtract both inch-fraction and metric measurement as they might be derived from a typical manufacturing part print or process description.

MM10 Skill Demonstrate proper general measurement techniques.

Skill Standard Demonstrate the proper use of common measuring devices used in manufacturing such as micrometer, vernier caliper, depth gage, steel rules, and thread gages.

MM11 Skill Demonstrate proper precision measurement techniques.

Skill Standard See MM 10

MM12 Skill Describe the appropriate application and use of precision measurement in manufacturing.

Skill Standard Complete MM 10 and then provide a description identifying the proper and appropriate use of each of the devices.

MM13 Skill Explain calibration requirements of various precision instruments.

Skill Standard After having participated in a training session about the use and calibration of a specific precision instrument, provide an oral explanation of the importance to calibrate the instrument and the frequency with which it should be done. The description should essentially match the recommendations of the manufacturer.

MM14 Skill Illustrate measurement differences when taken with calibrated and non-calibrated instruments.

Skill Standard See MM 13

MM15 Skill Match appropriate measurement tools with various types of measurement requirements.

Skill Standard Working alone, the individual will recognize and specify the necessary measuring tools for a given application. This skill will be evaluated within the context of the appropriate manufacturing environment.

MM16 Skill Demonstrate proper measurement tool usage.

Skill Standard Working alone, the individual must demonstrate proper storage, retrieval, calibration and use of common measuring tools in a manufacturing environment. Examples include ruler, micrometer, vernier caliper, plug gauges.

MM17 Skill State selection criteria for measurement tools.

Skill Standard Given 4 common measuring tools used in manufacturing, identify the measuring situation in which each would be used. Then provide a description of the proper selection of a proper measuring device given a specific need for taking an accurate measurement.

MM18 Skill Convert between US and metric measurement systems.

Skill Standard Working alone with a calculator, a metric to English conversion chart, and a part print, convert ten measurements on the print from metric to English or English to metric with 100% accuracy in five minutes.

MM19 Skill Convert fractional measurements to decimal measurement.

Skill Standard Many manufacturing situations require that individual workers be able to convert measurements from fractional form to decimal form. A competent worker must be able to perform this conversion accurately by using a table or other reference material. Proper performance would include knowledge of location of conversion table and ability to use table.

MM20 Skill Compute within measurement systems.

Skill Standard Demonstrate the ability to add, and subtract whole, fractions, and decimal numbers in both the English and metric system. This would be shown by completing 10 calculations in 5 minutes with 100% accuracy.

MM 21 Removed during validation

MM22 Skill Interpret results of measurements and calculations.

Skill Standard Demonstrate the ability to describe the results of a series of measurements on a typical manufactured part. This should include whether or not the part meets stated specifications, and the amount of variance. This description should be done both in writing and orally and should be approximately 100 words. Successfully done, the person to whom the description is given should be able to repeat it to another person such that the third person can clearly and accurately describe part variation.

MM23 Removed during validation

MM24 Skill Distinguish between general and precision measurement.

Skill Standard Accurately select from a list of 15 examples, those practices or situations that are classified as either general or precision measurement activities.

MM25 Skill Distinguish between US and metric measurement systems.

Skill Standard A person working in manufacturing may be faced with either US or metric measurements, either at different companies or in the same company. Therefore, a person must be able

to distinguish between US and metric systems. This would be demonstrated in a structured learning experience, or on a previous job. This should be done with complete accuracy.

Workplace Safety and Health

WH 1 Skill Assume responsibility for the personal safety of self and others.

Skill Standard In a situation with health or safety risks, a person with this skill will take and implement all appropriate personal safety precautions such as hard hats, eye protection, protective clothing or protective footwear. A fully competent worker will also insist that other co-workers take similar precautions. Being able to explain to others the reasons for safety, including personal protection and the effect on company finances and health care costs are essential.

WH 2 Skill Maintain a clean and safe work environment.

Skill Standard In order to protect personal safety and maximize productivity, it is important to maintain a clean and safe work environment. A person could demonstrate this skill in a work environment, in an avocational endeavor, or in a training/learning situation. Proper demonstration of this skill could be documented by a co-worker, supervisor, instructor/trainer, or self.

WH 3 Skill Demonstrate a positive personal attitude towards safety.

Skill Standard In order to fit in successfully in a high performance workplace where personal safety is an essential part of workplace practice, a good worker must demonstrate a positive personal attitude towards safety of self and company property. This means the person would always practice proper safety and would react with positive comments, tone of voice, and body language as part of any discussion on safety issues or practices.

WH 4 Skill Comply with established safety practices.

Skill Standard The individual or team will comply with established safety practices, 100% of the time on an ongoing basis. To be documented by written tests and third party observations.

WH 5 Skill Complete forms and paperwork as required.

Skill Standard It is important to the operation of a company that required forms and paperwork are completed on time and contain all requested information. The information should be spelled correctly and be legible. The skill could be documented from previous work experience or a structured learning experience.

WH 6 Skill Wear protective safety clothing as required.

Skill Standard Individual should demonstrate proper selection and use of protective safety clothing appropriate to the manufacturing environment.

WH 7 Skill Maintain and use protective guards on equipment and machinery.

Skill Standard The individual or team will maintain and use industry or company-specified protective guards on equipment and machinery, performing all specified procedures prior to equipment operation with 100% accuracy. To be documented with a checklist by third party observation.

WH 8 Skill Handle/store flammable (hazardous) materials appropriately.

Skill Standard The individual will handle and or store flammable (hazardous) materials appropriately, correctly handling and storing five flammable materials with 100% accuracy. To be documented by third party observation.

WH 9 Skill Use electrical devices correctly and safely.

Skill Standard Identify electrical devices and state how incorrect use can be hazardous.

WH10 Skill Prevent spontaneous ignition by practicing proper waste disposal habits.

Skill Standard Identify the factors that could lead to spontaneous ignition of waste and corrective measures to prevent this occurrence.

WH11 Skill Keep marked aisles clear of equipment and materials.

Skill Standard Describe what a marked aisle looks like and state why it has to be clear of equipment and materials.

WH12 Skill Interpret/display MSDS (Material Data Safety Sheets) as required.

Skill Standard Locate the MSDS and explain their purpose and how to use them for a specific material commonly used on the factory floor.

WH13 Skill Identify fire exits and fire-fighting equipment.

Skill Standard Locate closest fire exit and identify various pieces of fire-fighting equipment including alarms.

WH14 Skill Report unsafe practices to appropriate personnel.

Skill Standard The individual or team will identify and report all unsafe practices to appropriate personnel based on OSHA and/or company policies. To be documented by third party observations.

WH15 Skill Operate equipment in a safe, prescribed manner.

Skill Standard The team or individual will operate equipment in a safe, prescribed manner, completing the prescribed equipment function within established safety guidelines. To be documented by certification or third party observation.

WH16 Skill Locate power shutoff controls for all machinery/equipment.

Skill Standard The individual will locate power shutoff controls for all machinery/equipment, with appropriate speed for personal and co-worker safety, with 100% accuracy. To be documented by third party observation.

WH17 Skill Report malfunctions to appropriate personnel.

Skill Standard See MF 7

WH18 Skill Inspect material/equipment/fixtures for defects.

Skill Standard The individual and/or team will inspect and identify materials, equipment or fixtures for defects, given two problems in each specific area, with 100% accuracy. To be documented by third party observation.

WH19 Skill Determine weight/operating limits of equipment.

Skill Standard The individual will determine weight/operating limits of equipment, utilizing three pieces of equipment, within five minutes per function, with 100% accuracy. To be documented by third party observation.

WH20 Skill Perform periodic checks during operation to assure proper function.

Skill Standard The individual or team will perform periodic checks during operation to assure proper function. Three checks will be performed with 100% accuracy in an appropriate time to insure safety. To be documented by third party observation.

WH21 Skill Possess valid first aid card.

Skill Standard An individual will possess a valid first aid card at all times while at work, completing the safety course for initial card and then completing all refresher courses necessary to maintain certification. As documented by second party acknowledging that the card is valid.

WH22 Skill Determine need for CPR and administer as appropriate.

Skill Standard Individual will recognize the symptoms of heart failure and be able to respond appropriately. A written exam identifying the symptoms and steps involved in the administration of CPR will be augmented by a demonstration of the procedures. As documented as pass / fail by second party assessment of written exam and demonstration.

WH23 Skill Apply appropriate first aid techniques.

Skill Standard On an individual basis, respond appropriately to a workplace emergency and apply appropriate first aid procedures.

WH24 Skill 24 Define different types of chemical, biological, and physical hazards.

Skill Standard Given a defined workplace environment, the individual will recognize all general and specific workplace hazards. This may include: materials and chemicals used to complete the manufacturing processes, germs, bacteria, viruses, and other contagious microorganisms, as well as, noise, fumes, obstructions, unsafe equipment and procedures. The individual will perform a safety check (checklist) in a manufacturing environment in which s/he has been trained to work. A second party will document by reviewing the checklist during a walk-through with the individual.

WH25 Skill Respond to emergencies in the appropriate manner.

Skill Standard An individual must have knowledge of standard emergency procedures, including phone numbers, emergency call boxes, personnel to be contacted, emergency equipment to use, power and utility lock-outs, severe weather, fire, flood, and wind damage. Above must be performed in accordance with company standard operating procedures, as documented in training session performance and written/oral exam by a second party.

WH26 Skill Describe ergonomics and its importance to the manufacturing process.

Skill Standard Individual / team will describe the potential physical hazards employees are exposed to in their normal work environment. These will include: body position, repetitive motions, weight manipulation, lighting, eye strain. Creative solutions to these problems will be implemented in an economical and efficient manner. Second party will document proper understanding of these principles through written / oral exam.

Problem Solving

PS 1 Skill Explain the value of applying a problem solving system.

Skill Standard The individual will be able to explain how using a defined problem solving system can improve a situation or process and benefit the organization.

PS 2 Skill Apply a system of problem solving.

Skill Standard Working alone or in a group, the individual will be able to list and describe the steps of a problem solving model, and use the appropriate "tools" to solve an identified problem.

PS 3 Skill Identify opportunities for applying problem solving techniques.

Skill Standard Working alone or in a group, the individual will be able to identify and select problem(s) that present an opportunity for improvement in a given process.

Quality Assurance

QA 1 Skill Contrast quality manufacturing system with other manufacturing systems.

Skill Standard Working as part of a group, develop a 200-word description explaining the differences and advantages of manufacturing system focused on quality (meeting customer expectations) with one that is not. Include the impact on profits, and business reputation.

QA 2 Skill Identify effects of quality systems on specific manufacturing processes.

Skill Standard After having participated in a learning experience about a manufacturing situation not focused on quality, provide an oral description of several changes that could be made to move the process towards a quality system that will meet customer expectations, and result in most favorable cost, and delivery measures.

QA 3 Skill Explain the effect of quality on profit.

Skill Standard In today's manufacturing environment, it is essential to build quality products in order to make a profit which is necessary for continued operation. Quality is described as meeting customer expectations, and only if customer expectations are met can the company's product be sold and a profit produced. It is critical that an employee in a company knows and can articulate this concept in order to participate in company discussions about quality and customer satisfaction.

QA 4 Skill Identify the effects of continuous quality improvement.

Skill Standard Given a list of possible outcomes, both positive and negative, a competent employee will correctly select 5 major positive outcomes resulting from a business employing continuous quality improvement practices.

QA 5 Skill Demonstrate the ability to apply continuous quality improvement to the manufacturing process.

Skill Standard Working as part of a team, demonstrate the ability to participate and contribute to a continuous improvement activity. This would include diagramming current process, setting improvement goals, and clarifying process and purpose, brainstorming and reaching consensus, prototyping changes, collecting data, and standardizing improvements with beneficial results and documenting improved process.

QA 6 Skill Integrate improvement processes.

Skill Standard In a work situation, demonstrate the integration of process improvement activities and document success by showing improved process and output data. To be documented by co-workers, or process owners.

QA 7 Skill Define SPC (Statistical Process Control).

Skill Standard The individual will define SPC, within four minutes, list five major components of SPC with 100% accuracy. To be documented by third party observation or written test like activity.

QA 8 Skill Identify the relationship between SPC steps and specific production processes.

Skill Standard After receiving an explanation of a typical manufacturing process, identify the steps or situations that are appropriate for the application of SPC practices and what the potential benefits might be.

QA 9 Skill Apply SPC to specific production processes.

Skill Standard After having participated in a company specific learning activity, demonstrate the ability to accurately complete the steps necessary to complete the SPC according to the company standards.

QA10 Skill Analyze production specific processes.

Skill Standard After having been presented with various SPC data, provide a 100-word oral analysis of the situation about whether the process is conforming, and capable. Then provide a 50 word oral description of what steps might be taken to bring the process into conformity.

QA11 Skill Analyze and interpret test data for compliance to specifications.

Skill Standard After having been presented with various SPC data, provide a 100-word oral analysis of the situation about whether the process is conforming, and capable. Then provide a 50 word oral description of what steps might be taken to bring the process into conformity.

QA12 Skill Improve production process (if indicated by analysis of data).

Skill Standard After having been presented with various SPC data, provide a 100-word oral analysis of the situation about whether the process is conforming, and capable. Then provide a 50 word oral description of what steps might be taken to bring the process into conformity.

QA13 Skill Maintain production according to instructions.

Skill Standard While participating in a simulated or real manufacturing process, demonstrate the ability to collect data, interpret results, and make adjustments to bring the process within spec and maintain that situation.

QA14 Skill Identify customer problems.

Skill Standard As part of normal manufacturing responsibilities, it is important to be able to identify customer problems. Information will be presented either as part of customer response data or individual conversations. Customer problems must be identified and extracted from the data/information or conversation. This would be demonstrated either through previous successful workplace experience or simulations in a learning activity. The proper performance of the skill and application of knowledge would be determined either through observation; comparison to correct responses in the simulation, or best of all by getting concurrence from actual customers.

QA15 Skill Classify customer problems.

Skill Standard Identify potential customer complaints (customer service, product, price, shipping, time to market, marketing) and go to the appropriate source to handle complaints

QA16 Skill Determine causes of the problem.

Skill Standard Given a customer problem (e.g. malfunctioning product), identify what happened to bring about this problem (e.g. missing a key component)

QA17 Skill Apply problem-solving system.

Skill Standard Working as part of a group in learning situation, demonstrate the ability to apply a specific learned set of steps to solve or improve a manufacturing situation related either to a manufacturing process or a customer complaint. Identify and quantify the problem, look for root causes, develop a correction plan, implement plan, observe results and compare to plan, and consult with customers.

QA18 Skill Recommend possible solutions.

Skill Standard Working as part of a group in learning situation, demonstrate the ability to apply a specific learned set of steps to solve or improve a manufacturing situation related either to a manufacturing process or a customer complaint. Properly identify and quantify the problem, look for root causes, develop a correction plan, implement plan, observe results and compare to plan, consult with customer.

QA19 Skill Develop a plan utilizing a selected quality control system.

Skill Standard Working as part of a group in learning situation, demonstrate the ability to apply a specific learned set of steps to solve or improve a manufacturing situation related either to a manufacturing process or a customer complaint. Properly identify and quantify the problem, look for root causes, develop a correction plan, implement plan, observe results and compare to plan, consult with customer.

QA20 Skill Evaluate process selected versus desired goals.

Skill Standard Working as part of a group in learning situation, demonstrate the ability to apply a specific learned set of steps to solve or improve a manufacturing situation related either to a manufacturing process or a customer complaint. Include identify and quantify the problem, look for root causes, develop a correction plan, implement plan, observe results and compare to plan, consult with customer.

Blueprint Reading

BR 1 Skill Define basic blueprint terminology.

Skill Standard The individual will define basic blueprint terminology such as title block, border, views, notes, revision blocks, etc. In addition, the individual will recognize the intent of the drawing and its use in manufacturing.

BR 2 Skill ***Identify different dimension methodologies.***

Skill Standard — The individual will differentiate between dimensions of location and size. These dimensions may be represented as ordinate, base line, tabular, etc.

BR 3 Skill ***Identify general note symbols.***

Skill Standard — The individual will identify general note symbols and their applications within a manufacturing environment. Examples of symbols include finishing requirements, material specifications, machining/manufacturing specifications, assembly symbols, ANSI symbols, ISO symbols, etc.

BR 4 Skill ***Locate notes on a print.***

Skill Standard — The individual will locate notes on a print using industry standards, using three drawings with two minutes per note and 100% accuracy.

BR 5 Skill ***Interpret commonly used abbreviations and terminology.***

Skill Standard — The individual will interpret commonly used abbreviations and terminology used on prints in the manufacturing environment, using three drawings with five abbreviations or terms each with 100% accuracy and a limit of two minutes per term/abbreviation. To be documented by a third party observer.

BR 6 Skill ***Determine tolerances associated with dimensions on a drawing.***

Skill Standard — All dimensions on a blueprint have either a specific or an implied tolerance. Given a drawing, the individual must distinguish the tolerance that applies to a specific dimension.

BR7 — Removed during validation

BR 8 Skill ***Identify types of lines within a drawing.***

Skill Standard — Working alone, identify the representation of the various lines found on a drawing. Examples include hidden lines, object lines, extension lines, section lines. Individuals should read various drawings and identify lines with 100% accuracy.

BR 9 Skill ***List the essential components found in the title block.***

Skill Standard — Individually, the participant should interpret the following information from a blueprint title block: company name, part name and number, material, name of designer and checker, revision history, and other important information regarding the part.

BR10 Skill ***List the essential components found in the revision block.***

Skill Standard — Recognize the changes through which the design has progressed from the original design. Interpret the meaning of revision block symbols and notations. Match the revision block components with the actual drawing features.

BR11 Skill ***Identify orthographic views.***

Skill Standard — Recognize the three basic views which may be represented on the drawing; front, top, right side. Identify if the print is drawn in first or third angle projection. Detect features represented in one view and find those same features in another view

BR12 Skill Identify isometric views.

Skill Standard On a drawing containing orthographic and isometric, properly identify the isometric view. Provide a 50-word description of what constitutes an isometric view and its relation to orthographic views.

BR13 Skill Identify positions of views: top, front, side, auxiliary, section.

Skill Standard Given an orthographic drawing, identify all appropriate views according to their position or placement on print. Or, given an actual part, the individual will be able to match the views to the appropriate surfaces.

BR14 Skill Visualize one or more views from a given isometric or pictorial representation of an object, or from the actual object

Skill Standard See BR 10-13

BR15 Skill Determine the scale of the view or section.

Skill Standard Based on the title block information, physical scaling of view, and standard drawing scale, determine appropriate scale of view or section.

BR16 Skill Check for revisions.

Skill Standard Given a series of drawings, some of which contain revisions and proper notation, properly identify which ones are the most current revisions, and identify which drawings do not contain revisions.

Manufacturing Fundamentals

MF 1 Skill Perform basic arithmetic functions.

Skill Standard Working alone with a calculator, the individual will be able to perform basic mathematical operations (addition, subtraction, multiplication and division); convert from one form to another using whole numbers, fractions, decimals, or percentages. Complete ten problems for each mathematical operation within a time frame of 30 minutes with 100% accuracy.

MF 2 Skill Use measuring instruments.

Skill Standard Working alone using basic measuring instruments the individual will demonstrate proficiency by taking 5 specified measurements for each part and recording results within an acceptable variation.

MF 3 Skill Use hand calculators.

Skill Standard The individual will use hand calculators to demonstrate basic arithmetic functions, performing ten arithmetic calculations, two minutes per calculation with 100% accuracy. To be documented by a written performance activity.

MF 4 Skill Calculate with percents, rate, ratio and proportion with the use of a calculator.

Skill Standard The individual will calculate percents, rate, ratios, and proportions with the use of a calculator, performing two problems per function, three minute limit per problem with 100 % accuracy. To be documented by written activity.

MF 5 Skill Make reasonable estimates of arithmetic results without the use of a calculator.

Skill Standard The individual will make reasonable estimates of arithmetic results without the use of a calculator, performing ten problems, one minute per problem, with accuracy based on predetermined limits. To be documented by a written performance activity.

MF 6 Skill Demonstrate basic mechanical skills.

Skill Standard The individual or team will demonstrate basic mechanical skills, using proper safety techniques, efficient methodology performing all mechanical skills in reference to their established job tasks. To be documented by third party observation.

MF 7 Skill Identify and report equipment malfunctions.

Skill Standard The individual or team will identify and report equipment malfunctions, following predetermined procedures, putting safety first and observed by a third party for documentation.

MF 8 Skill Follow established safety procedures when around machinery/equipment.

Skill Standard Given a piece of machinery or equipment, identify the proper safety procedures and follow them.

MF 9 Skill Describe the importance of correct fixturing and work holding devices.

Skill Standard Provide a 50-word description including 5 specific reasons for using proper work holding and fixturing devices. Included should be mention of product, equipment, and personal safety, as well as accuracy and quality.

MF10 Skill Follow established safety procedures when using machine tool.

Skill Standard Individual will practice safety procedures (100% of the time) that have been established by the company in regard to using any or all machine tools, with documentation by a second party observation conducted periodically throughout the workday for at least 10 minutes.

MF11 Skill Identify a variety of common machine tools.

Skill Standard Individual will identify the common machine tools used within the manufacturing environment with 100% accuracy as assessed by a second party oral exam, naming the tool and asking the individual to select that tool from an assortment of tools.

MF12 Skill Describe the function of specific machine tools.

Skill Standard The individual will describe the function of each and every machine tool being used in that manufacturing environment, with 100 % accuracy, including tool room, production machinery, special machines; with documentation by a second party oral exam.

MF13 Skill Inspect machine tools for defects.

Skill Standard The individual will inspect tools for defects, with 100 % accuracy, in order to maintain tools and equipment in top working condition, as documented by a second party observation of the inspection. This would include being free of defects such as abnormal noise, fluid leakage, broken or damaged accessories, frayed electrical cords, and/or missing safety devices.

MF14 Skill Maintain company-provided machine tools.

Skill Standard An individual will be aware of maintenance logs and schedules and can specify the necessary maintenance procedures to keep the machine tool in good operating condition, as measured by participating as a team member in the decision-making process of machine maintenance.

MF15 Skill Locate and retrieve production materials specific to process flow and delivery schedule.

Skill Standard The individual or team will locate and retrieve production materials required to maintain process flow and the delivery schedule with 100% accuracy. To be documented by third party observation or written task sheets.

MF16 Skill Receive and communicate process flow instructions and delivery schedules.

Skill Standard Demonstrate the ability to receive and then communicate to others process flow instructions and delivery schedules.

MF17 Skill Operate hand tools in a safe prescribed manner.

Skill Standard The individual will demonstrate the proper and safe hand tool operation with all company-provided hand tools following correct procedures in regard to personal and co-worker safety. To be documented by third party observation.

MF18 Skill Inspect hand tools for defects.

Skill Standard The individual will identify defects in hand tools, identifying the four common defects in three hand tools with 100% accuracy. To be documented by a third party or performance assessment.

MF19 Skill Maintain company-provided hand tools.

Skill Standard The individual will properly identify and perform proper maintenance on all company provided hand tools to established standards. To be documented by a third party observer.

MF20 Skill Interpret prints to determine appropriate tool usage.

Skill Standard The individual will interpret prints to determine appropriate tool usage, using two different prints with various tool requirements with 100% accuracy. To be documented by a third party observer.

MF21 Skill Follow electrical troubleshooting procedures.

Skill Standard Demonstrate the ability to follow a set of instructions for troubleshooting an electrical problem in a simple switched circuit. Would be properly completed if the problem causing non-function is properly identified.

MF22 Skill Identify types of work-saving devices used in manufacturing.

Skill Standard From a list of 20 examples, select the 10 that provide work-saving opportunities in a typical manufacturing situation.

MF23 Skill Describe scenarios in which work-saving devices can be used.

Skill Standard Provide three 25-word scenarios describing appropriate and beneficial use of work-saving devices in a manufacturing environment. These might include tool-balancing devices, product/work positioning devices, and product holding devices.

Business Planning and Operation

BO 1 Skill Identify the organizational need for profit.

Skill Standard Provide a 100 to 125-word explanation of the need of an organization to generate an operating profit. The description should make reference to increasing shareholder/owner equity, potential for profit sharing and bonuses, and new business development and research. The description can be provided in written or oral form.

BO 2 Skill Identify opportunities for profit in manufacturing processes.

Skill Standard As a part of a work team seeking to continuously improve processes, an individual should be aware of possible opportunities for increasing profit in manufacturing. Therefore, a successful worker should be able to list in a conversation, 6 to 10 such opportunities: e.g. reduced assembly or handling steps, reduced use of materials, reduced the time of the process, reduced scrap, increased quality, improved alignment with customer expectations, reduced labor content, additional use of available machine time, and additional use of employee time.

BO 3 Skill Identify possible barriers to profit in manufacturing processes.

Skill Standard Describe at least five things that can negatively affect a businesses profit. These could include scrap, re-work, lost-time accidents, excess direct or overhead costs, need for after-sale service, penalties for late delivery, and product failing to meet functional requirements. The description can be provided either orally or in written form by either an individual or workgroup.

BO 4 Skill Identify strategies that may maximize profit potential in manufacturing processes.

Skill Standard Working alone or as part of a group, describe how competitive pricing, meeting and exceeding customer quality expectations, and on time delivery enhance the profit potential for a company through increased orders and improved competitive position.

BO 5 Skill Recognize a business plan that provides for an acceptable profit.

Skill Standard Given two different process (business) plans, select the one that offers the best profit potential based on direct and indirect costs, including time and materials. This should be done as part of a work group.

BO 6 Skill Identify the components that lead to customer satisfaction.

Skill Standard Working alone list 5 factors that affect customer satisfaction including cost, quality, delivery, suitability to purpose, and product life cycle. This explanation should be of approximately 75 words presented either orally or in writing and acceptable to three other co-worker/students.

BO 7 Skill Identify possible actions that may lead to customer satisfaction.

Skill Standard State three things that an individual employee can do that will lead to increased customer satisfaction. This should include both product features and the importance of communications with the customer such as listening carefully, timely response to requests, and, when possible, anticipating customer needs.

BO 8 Skill Identify the ways that the level of customer satisfaction may affect company success.

Skill Standard Provide 3 examples of relationships between cost, quality, and delivery resulting in customer satisfaction and the potential impact on company profit and success. This would best be demonstrated in a written form, but would be acceptable in a conversational form.

BO 9 Skill Explain the importance of a business reputation.

Skill Standard Give an oral description of approximately 150 words about the importance of the reputation of a business and its potential impact on the success of the company. This should include references to additional orders and support of pricing structures.

BO10 Skill Identify the ways that customer satisfaction influences a business reputation.

Skill Standard As part of a group, develop a 150-word written description of the impact that customer satisfaction has on a business reputation and ultimately on business success and continuation.

BO11 Skill Identify possible actions that may be used to correct customer dissatisfaction.

Skill Standard Create a list of 4 things that can be done to improve a situation in which a customer (either internal or external) expresses dissatisfaction. This should be done both orally and in written form.

BO12 Skill Define a safe work environment.

Skill Standard Working alone, the individual will survey a designated work section and identify a minimum of 5 safe conditions and a minimum of 5 correctable unsafe conditions.

BO13 Skill Identify immediate and real costs of an accident.

Skill Standard Provide an oral or written paragraph of approximately 100 words identifying 5 possible negative cost factors that may result from an accident that damages equipment, product, or injures a worker.

BO14 Skill Identify methods of preventing accidents in the workplace.

Skill Standard Identify 10 specific actions or precautions that can be used to reduce the potential of accidents in the workplace. Include references to equipment maintenance, housekeeping, equipment safety devices, personal safety protection devices, and proper work procedures.

BO15 Skill Define the term value-added.

Skill Standard An individual will provide the definition of "value-added" and explain its context in terms of the manufacturing environment, as demonstrated to a second party in the form of a written definition or oral discussion.

BO16 Skill Identify steps within manufacturing processes that determine cost.

Skill Standard Identify 10 items and manufacturing processes that contribute to the cost of a product. These items should be selected from a list of 20 items including both items that do and do not determine cost.

BO17 Skill Define the term profit.

Skill Standard An individual will provide the definition of "profit" and will explain its context in terms of the manufacturing environment, as demonstrated to a second party in the form of a written definition or oral discussion.

BO18 Skill List the benefits that are employer paid or provided.

Skill Standard An individual or team will list (with 100 % accuracy) the benefits that are paid for or provided by the employer, such as: vacation, sick leave, funeral leave; medical, dental, optical insurance; workers compensation, and any retirement or pension plans, so as to ensure that there is a clear understanding of the benefits provided. As documented by a benefits officer or other human resources personnel.

BO19 Skill List the benefits that are offered to employees for their optional participation.

Skill Standard An individual or team will list 100 % of the benefits that are available to employees for optional participation and at cost to the individual, such as: life insurance, additional medical insurance, cafeteria / 401K plans, etc., to ensure that there is a clear understanding of all optional benefits. As documented by a benefits officer or other human resources personnel.

Computer Use

CU 1 Skill List possible computer applications in manufacturing processes.

Skill Standard Without reference materials, list 10 applications of computers (including software and networks) that will result in improvements in the manufacturing and support process.

CU 2 Skill Identify possible effects of introducing computers into manufacturing processes.

Skill Standard Alone or in a team, list the effects of bringing computers into the mfg. process. Should include references to schedule, cost, and quality. And, should include the impact on the skill and knowledge requirements of all members of the company organization.

CU 3 Skill List various methods of tracking inventory quantities.

Skill Standard Alone or in a team, identify the following 4 methods of tracking inventory quantities: Paper and pencil, computer systems, inventory tracking cards and physical count.

CU 4 Skill List factors that determine inventory demand.

Skill Standard Alone or in a team, list 4 factors that affect the demands on inventory. This should be included in a 150-word written or oral description including the benefits of minimal inventory quantities, the cost of work in process, and the concepts and requirements of just-in-time delivery.

CU 5 Skill Demonstrate use of an industry-accepted word processing software package.

Skill Standard An individual will demonstrate proficiency in an appropriate word processing package, as illustrated by the completion of a writing sample such as a business letter, memo, or technical report. Documents will be produced in an appropriate time frame in the presence of a third party.

CU 6 Skill Demonstrate use of an industry-accepted spreadsheet software package.

Skill Standard An individual will demonstrate proficiency in an appropriate spreadsheet software package, as illustrated by the completion of a spreadsheet, chart or table. Document will be produced in an appropriate time frame in the presence of a third party.

CU 7 Skill Demonstrate use of an industry-accepted database software package.

Skill Standard An individual will demonstrate proficiency in an appropriate database software package, as illustrated by the completion of mailing list, tables, or other appropriate documents. Documents will be produced in an appropriate time frame in the presence of a third party.

CU 8 Skill Demonstrate use of an industry-accepted statistical processing software package.

Skill Standard An individual will demonstrate proficiency in an appropriate statistical processing software package, as illustrated by the completion of appropriate charts, tables or measurements based upon given data. Document will be produced in an appropriate time frame in the presence of a third party.

CU 9 Skill Demonstrate use of an industry-accepted graphic software package.

Skill Standard Working alone with the use of a computer and graphics software, the individual must be able to create pie, bar, hi/lo, area, and line graphs based on predetermined data values, and be able to choose the graph type that is best suited to represent the data interpretation.

Process Control And Improvement

PC 1 Skill List a variety of process control applications.

Skill Standard The individual must identify manufacturing process variables to 100% accuracy. These must be controlled for quality and reliability. This will include controlling quality of incoming materials, amounts of materials, operator skills, adjustable parameters: time, temperature, pressure, speed, voltage, etc. Documented by second party review of written list.

PC 2 Skill Collect and analyze information to determine and improve work processes.

Skill Standard The individual or group must identify important parameters and collect the data in a scientific fashion. Then the data will be analyzed statistically to look for trends or variability in process. The individual or group will determine the appropriate adjustments to improve the process. These skills will be assessed by a second party to determine if continuous process control is actually occurring.

PC 3 Skill Explain the advantages and disadvantages of just-in-time inventory.

Skill Standard Working as part of a group, after participating in a company specific training activity, complete a 200 word description of the advantages of just-in-time delivery. This should include both the company as a supplier and customer, and should include the impact on cost and schedule parameters for both the supplier and customer.

PC 4 Skill Create a project plan.

Skill Standard Working as part of project team., complete a project and process plan such that another team can or could complete the project and sub-processes. Then, after having reviewed another team's plan, produce an improved plan that improves on cost, quality, and schedule.

Workforce Issues

WI 1 Skill Recognize the difference between a team environment workplace and a conventional workplace.

Skill Standard In order for individuals to select the type of workplace in which they would like to be involved in, it is important that they be able to recognize the difference between a workplace with a team environment and a workplace that is not organized with work teams. This would be done by asking questions of the employer and/or current employees during a job interview or research about possible work places. This could be judged in a learning situation by presenting a learner with typical workplace scenarios and asking for the correct response.

WI 2 Skill Explain how organizational structure affects a manufacturing process.

Skill Standard Explain in approximately 200 words how different organizational structures can affect different kinds and sizes of manufacturing processes. The explanation should reference a traditional supervisor-led organization and compared to work teams and self directed empowered workers. Then list the affects of these different structures.

WI 3 Skill Explain the characteristics of a diverse workforce.

Skill Standard Since many businesses are increasing the diversity of their workforce, it is important that a competent worker be able to define and recognize the characteristics of a diverse workforce. This would be accomplished if four characteristics of such a workforce were provided in a conversational situation. This could also be documented from a previous work experience or company sponsored/selected training program.

WI 4 Skill Identify organized labor's role in employee wages, benefits, and safety issues.

Skill Standard Working as part of a group in a learning environment, develop a 200-word description of the role of organized labor wages, benefits, and safety issues. This description should be consistent with materials developed by various labor organizations.

WI 5 Skill ***List steps of a grievance or dispute resolution procedures.***

Skill Standard: Following the guidelines set forth in materials provided by organized labor, describe in written or oral manner the steps to be followed to resolve a dispute or grievance in a workplace with and organized workforce.

WI 6 Skill ***Identify good personal ethical characteristics and behavior.***

Skill Standard: From a list of acceptable and unacceptable workplace behavior, covering such things as punctuality, following directions, and cooperative behavior, properly identify all of the correct and incorrect behavior.

WI 7 Skill ***Demonstrate good personal ethics.***

Skill Standard: Have documented and verified from a previous work or organized group activity, the ability to follow ethical behavior and ethics acceptable and approved by other members of the workforce or group.

WI 8 Skill ***Identify good ethical business behavior.***

Skill Standard: To realize long term success in the workplace, a person must demonstrate commonly accepted good ethical business behavior. Therefore, a person must know what acceptable ethical behavior includes and excludes. So, presented with a list of possible behavior, the good and acceptable behavior will be identified as such and unacceptable behavior will also be identified. A competent employee will be able to correctly identify twenty out of twenty-five from a provided list.

WI 9 Skill ***Differentiate between good and poor business ethics practices.***

Skill Standard: Given examples of several good and poor ethical practices in the workplace, correctly select and identify properly those that are good and accepted and those that are poor practices and generally unacceptable in the workplace.

WI10 Skill ***Match employee responsibilities to employer expectations.***

Skill Standard: Given lists of common expectations of manufacturing employers, and a range of employee responsibilities and actions, make a proper match between the items in the two lists.

WI11 Skill ***Define discrimination, harassment and equity.***

Skill Standard: The individual will correctly define discrimination, harassment and equity within two minutes per definition and with 100% accuracy. To be documented by third party observation or a written assessment.

WI12 Skill ***Demonstrate non-discriminatory behavior.***

Skill Standard: Functioning in a real or simulated situation, receive feedback from other members of the group that non-discriminatory behavior has been demonstrated.

Workplace Skills

WS 1 Skill Demonstrate consistently punctual arrival.

Skill Standard Given a specific start time by an employer, be at the scheduled work activity ready to begin by the predetermined time. Arrival at a specific time is important so planned activities can be accomplished and other employees are not kept waiting to work again.

WS 2 Skill Document regular attendance.

Skill Standard An individual will be able to document regular attendance with 100% accuracy for a period equal to their employment probation.

WS 3 Skill Demonstrate enthusiasm and confidence about work and learning new tasks.

Skill Standard The individual will display confidence and enthusiasm for accepting the opportunity for new and challenging work assignments.

WS 4 Skill Demonstrate safe, careful use, treatment and maintenance of tools, equipment and machines.

Skill Standard Given the tools and equipment used for an individual's job, show a supervisor or peer how to properly use and maintain each tool and piece of equipment.

WS 5 Skill Demonstrate appropriate dress and hygiene for successful employment.

Skill Standard Describe minimal personal hygiene requirements and given specific work environments, describe appropriate dress.

WS 6 Skill Demonstrate the ability to act in a polite and respectful way towards co-workers.

Skill Standard In a group environment, interact with coworkers while displaying courtesy and respect.

WS 7 Skill Demonstrate the ability to complete tasks on time and accurately.

Skill Standard Given a list of tasks in specific order with time deadlines and accuracy levels for each, complete each one in order, accurately and by the deadline.

WS 8 Skill Demonstrate the ability to make career decisions.

Skill Standard Alone or with family input, identify different job positions that would match personal and professional interests.

WS 9 Skill Demonstrate the ability to use labor market information.

Skill Standard Analyze current job availability and related information such as rate of pay, potential growth or decline and overall need for positions of this type.

WS10 Skill Prepare a resume and letter of application/interest.

Skill Standard Gather necessary dates and information (transcripts, employment history, references, and professional memberships) and prepare a resume listing each of the above in chronological order using the following format: Objective, Work experience, Education, Personal interests, References. Prepare a letter of application using standard letter format and including the following information: the job position (if applicable) for which an individual is applying, and a few general paragraphs describing the interest in this position.

WS11 Skill Fill out an application for employment.

Skill Standard Given a blank application form, fill in the blank areas legibly and correctly with the information requested

WS12 Skill Participate in an employment interview.

Skill Standard Dressed in appropriate interview attire, role-play a job interview with a human resource staff person at a company

WS13 Skill Follow directions and procedures.

Skill Standard Given a set of directions or procedures (e.g. to clean up a workspace , prepare something for shipping), follow each step and complete the task.

WS14 Skill Be depended upon on not to steal equipment and materials.

Skill Standard Given access to equipment and materials, an individual does not steal either equipment or materials.

WS15 Skill Be truthful in all communications with co-workers and supervisors.

Skill Standard When placed in a situation where an individual must communicate either verbally or in written form with co-workers or supervisors, individual will not make false statements.

WS16 Skill Accept constructive criticism.

Skill Standard Given criticism of a task recently performed, appearance, or conversation, an individual listens to the critical comments and responds in a positive manner.

WS17 Skill Demonstrate an ability to learn new skills and behavior.

Skill Standard Given a list of necessary new skills or behavior, describe the methodology that would be used for learning each new skill or behavior and then perform each skill and exhibit each changed behavior.

WS18 Skill Demonstrate a willingness to work.

Skill Standard Given an assigned task the individual chooses to act in a timely manner to complete the assignment.

WS19 Skill Demonstrate a willingness to learn.

Skill Standard Receive documentation from instructors or other group members that a willingness to learn new information or skills has been demonstrated.

WS20 Skill Work with minimal supervision.

Skill Standard Demonstrate the ability and willingness to begin and follow tasks with little or no supervision, direction or prompting. This could have been demonstrated in school, community, workplace, scouting, social, or church activities.

WS21 Skill Plan and organize work.

Skill Standard Through successful accomplishment in organized activities such as community, church, school, or scouting activities, document the ability to plan and organize work both for individuals and groups such that the necessary work is successfully accomplished.

Learning Skills

LS 1 Skill Identify personal preferred learning styles.

Skill Standard Given four possible learning styles and examples of a thinking skill and a performance skill, state whether you can best learn each through oral instruction or demonstration by another person; alone through reading the instruction manual or self-discovery. Individual must determine their personal learning style for thinking skills and performance skills.

LS 2 Skill Demonstrate ability to learn new process steps.

Skill Standard Given a written description of a three-step assembly process, demonstrate the ability to complete the assembly. The produced assembly must match the specifications of the original assembly. Then one step in the process should be changed and the new assembly should be properly completed. This example could instead be for the mixing of powdered or liquid materials instead of an assembly. This should be specific to the workplace context.

LS 3 Skill Implement new process steps given oral instructions.

Skill Standard Given a product change and necessary new process steps, demonstrate the ability to follow the new oral instructions by properly completing the process.

LS 4 Skill Read process instructions and implement appropriate steps.

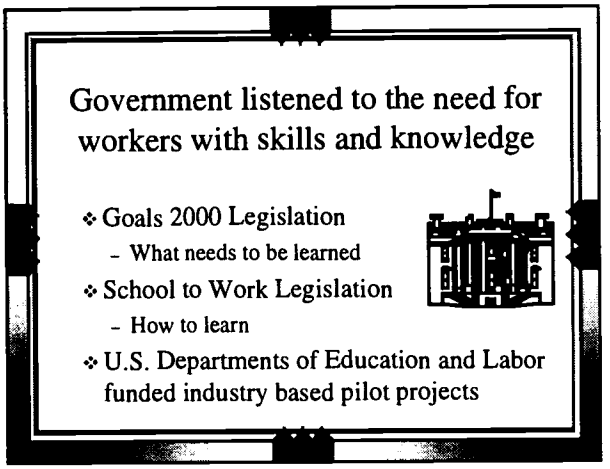
Skill Standard Given a set of written instructions, read and interpret the appropriate steps and apply them to the process.

LS 5 Skill Participate in product or process specific training and report significant information.

Skill Standard In a training environment, participate interactively (with team, instructor, equipment) and take notes during the training. This would be demonstrated by the fact that another individual not in the original training could successfully complete the process successfully.

Background

Between 1993 and early 1997, the U.S. Department of Education commissioned The National Coalition For Advanced Manufacturing (NACFAM): ***to determine and validate occupational skill standards for workers in advanced high-performance manufacturing***. This project is part of the joint effort between the Departments of Education and Labor to establish voluntary national occupational skill standards in concert with School to Work and Goals 2000.



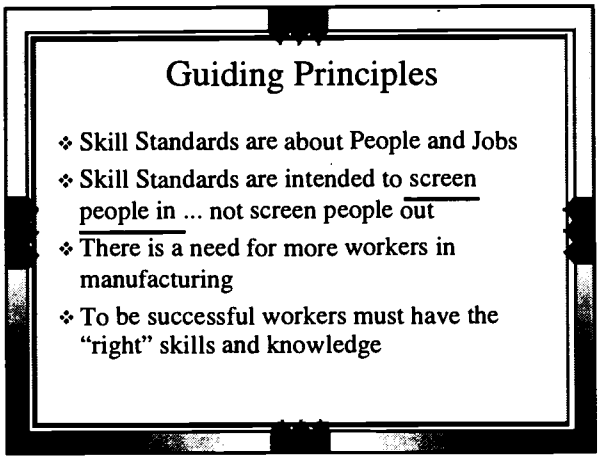
Drawing from the broad NACFAM membership, the project was conducted through a coalition of business, education, and labor representatives who are giving their time to this critical work. NACFAM is an industry-led non-profit association committed to preparing U.S. Industry for the information age through its services and programs.

The project was designed to learn from the modern advanced high performance manufacturing workplace, in its many variations, to determine:

- how the nature of work is changing and being reorganized;
- how the responsibilities essential to success in advanced manufacturing are being divided and assigned into jobs; and
- what tasks, skills and competencies are needed to perform those jobs.

Based on input from successful and forward looking firms and front line production workers, the research establishes the skill standards needed to specify and certify production workers who can and will be successful in the manufacturing jobs of today and tomorrow.

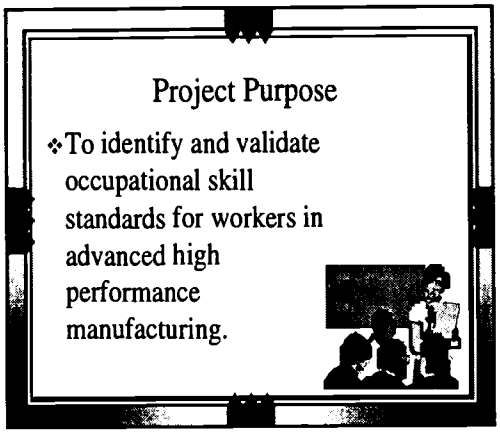
The standards detail the core knowledge and skills that workers in manufacturing firms must possess to perform their jobs effectively. The standards define the agile and flexible worker of the future. The successful worker of the future must possess a holistic set of knowledge and skills in areas such as math, science, problem solving, communication, and teamwork. The worker must be able to apply these skills in an environment of flexible automation and modern manufacturing technologies and techniques.



Advanced high performance firms are those using computer-based technologies, teamwork, and communications integrated into a system capable of furnishing a mix of products in large or small volumes, with both the efficiency of mass production and the responsiveness of custom manufacturing. Such firms are further characterized as having empowered workers, using TQM and JIT, and continuously improving to be lean and agile.

As the primary customers of the process, advanced manufacturing firms established the basis for the skill standards. This was accomplished through site visits, group meetings and questionnaires involving business managers, supervisors, and, most importantly, current successful workers in advanced manufacturing environments.

These skill standards will enable clear and specific communication between industry, education and students of all ages. This will help to ensure that schools know what to teach, instructors remain up-to-date, and students learn what they need to know to succeed in their chosen occupation. The standards will facilitate the alignment between the manufacturing community and the educational system responsible for preparing people to be successful workers.



Education and training organizations serving future and current workers are also participating in the development process. In this way they will be able to design their programs, curricula and learning activities using current and forward-looking information about work organization, emerging occupational clusters, and career paths based on skill standards.

In the first eighteen months (November 1993 to April 1995), the project focused on determining and validating the skills that are important to employers. In the second eighteen months (May 1995 to February 1997), the project developed the final standards, including the conditions and context for the skill, and the level of performance. The project also endeavored to determine the most appropriate assessment, skill documentation, and certification system.

The anticipated benefits of the project are:

- significantly improved understanding of how the application of advanced manufacturing processes affects the organization of work ;
- increased productivity and global competitiveness of American industry;
- more rapid adoption of appropriate advanced technologies and methods due to assured availability of qualified employees;
- more appropriate education and training programs; and
- greater opportunity for individuals to obtain the high-paying jobs available in advanced manufacturing.

Thank You

Project Committee Members & Supporters

NACFAM wishes to express sincere appreciation to the following organizations and individuals who have given graciously of their time and effort to help guide the work of the project.

AACC
Mr. Jim McKenney

AC Delco Systems
Mr. Bob Trouskie

Aerospace Industries Association
Ms. Virginia Lopez

American Society For Engineering Ed.
Ms. Ann Leigh Speicher

AMT
Mr. James Wallbeoff

ASTD
Ms. Mary McCain

AT&T
Ms. Sheron Kennedy

Austin Community College
Ms. Debra Iversen

Autodesk Inc.
Mr. Wayne Hodgins

BGSI
Mr. Chris Yanckello

CAMP
Ms. Virginia Ainslie

Caterpillar Foundation
Mr. Henry Holling

Center On Education For Employment
Mr. James Green

Central Florida Community College
Dr. Hugh Rogers

Charmilles Technologies Corporation
Mr. Harry Moser

Community College Of Philadelphia
Mr. Bradshaw Kinsey

Cybernet Systems Corporation
Ms. Heidi Jacobus

Delaware Valley Industrial Resource Ctr.
Mr. Joseph Houldin

Delaware Valley Industrial Resource Ctr.
Dr. Helen Richardson

Donsco Incorporated
Mr. Fred Ihrig

EDC
Dr. Joyce Malyn-Smith

EMPF
Dr. Larita Killian

Fashion Institute of Technology
Mr. Aaron Schorr

Fashion Institute Of Technology
Ms. Tree Marr

FIM & NACFAM
Mr. Leo Reddy

GE Superabrasives
Mr. David Cunningham

Grand Rapids Community College
Ms. Paula Stark

Grand Rapids Community College
Mr. Tom Boozer

Grand Rapids Community College
Ms. Vicki Janowiak

Gwinnett Technical College
Mr. Rex Bishop

Hughes
Mr. Bill Scanlon

Hughes
Ms. Roni Dotson

Johnson Controls
Ms. Sara Ralph

Light Machines Corporation
Mr. Michael Ogilvy

Lockheed Martin
Mr. William Wise

Lorain County Community College
Ms. Sandra Everett

Macomb Community College
Dr. Jim Jacobs

Michigan Technological University
Dr. Curtis Tompkins

Milwaukee Area Technical College
Mr. Greg Holther

Milwaukee Area Technical College
Ms. Crystal Wallendal

Milwaukee Area Technical College
Mr. Phil Leverault

National Alliance Of Business
Ms. Michelle Morrison

National Alliance of Business
Ms. Louise Bertsche

National Association Of Manufacturers
Ms. Phyllis Eisen

National Center For Mfg Sciences
Ms. Marti Reesman

Natl Voc Tech Education Foundation
Ms. Madeleine Hemmings

NIST
Mr. Chuck Ernst

Northwestern Michigan College
Ms. Roberta Teahen

Osram Sylvania
Mr. Rob Robinson

Philip Morris USA
Mr. Joel Schendel

Production Technology, Inc
Mr. Thomas Fiorino

Rochester Institute Of Technology
Mr. Bob Graham

Science Applications International Corp.
Mr. Dave Damin

Siemens
Mr. John Tobin

Siemens
Mr. Travis Hembree

Strategic Education Services Inc.
Mr. David Munger

Trident Technical College
Dr. Bill Brown

UAW Chrysler National Training Center
Mr. Enzo Paglia

UAW/Chrysler
Mr. Ron Gossett

Univ Of New Orleans Higher Ed Counc.
Dr. Gordon Mueller

University Of Wisconsin-Extension
Mr. Ken Mericle

VICA
Mr. Stephen Denby

Waukesha County Technical College
Mr. Jim Mullarkey

Wisconsin Teahnical College System
Dr. Betty Brunelle

WIDS
Ms. Judy Neill

Winterton Associates
Dr. Joyce Winterton

Work And Technology Institute
Mr. Brian Turner

Wyoming Public Schools
Dr. Anita Rutlin

Xerox
Mr. Phil Micheau

Acknowledgement

The initial activities of the project focused on researching existing literature and reviewing the work of other similar and related projects. Data and information relative to manufacturing skill standards was gathered and synthesized into an initial set of skills. Sources of important information were:

- Boeing - they did an extensive amount of work identifying important workplace skills which they made available to us.
- Indiana Workforce System - they have been conducting a project similar to the National projects and developed similar information.
- Grand Rapids Manufacturers Council - this was a locally based project in Grand Rapids Michigan.
- Philip Morris - provided information about some of their activities
- Baltimore Public Schools - did job analysis work on for a manufacturing curriculum
- State of Wisconsin - statewide skills identification through WISCIC
- AT&T - shared information about their skill identification activities
- Project Smart - EDC's project in Cleveland
- Other local, state, and national skill standards Projects
- More than 100 previous workforce development projects - these projects were conducted as part of Michigan's 107 program
- MTAG - State of Washington
- MAST Program - TSTC & NSF/ATE
- Pennsylvania, Illinois, Oregon, Ohio
- ITI/Detroit - ITI conducted a critical skills study for the City of Detroit
- Related Conferences - presentations at AVA, ASTD, etc.
- VTECS
- SCANS

Appreciation

The initial set of information served as the basis for several specific site visits during which the context and the skill information were reviewed and improved. The project is thankful to all companies involved for allowing access and time to help us learn about the manufacturing process and the necessary skills in current work settings.The primary site visits took place at the following companies:

AC Delco Systems
Rochester, NY
Acro Industries, Inc.
Rochester, NY
Donlee Technologies, Inc.
York, PA
Donsco, Inc.
York, PA
Fairchild Space
Germantown, MD
Harley-Davidson
Milwaukee, WI
Hilton Tool & Die, Corp.
Rochester, NY
Johnson Controls
Milwaukee, WI
Nippondenso Tennessee
Maryville, TN
Osram Sylvania
York, PA
Rapidac Machine Corp.
Rochester, NY
Rockwell/Collins
Coralville, Iowa
Steeltech Manufacturing
Milwaukee, WI
Stone Construction Equipment,
Rochester, NY
Waukesha Engine
Waukesha, WI
Weidmüller Electric
Richmond, VA
Newport News Shipbuilding
Newport News, VA

Sincere Gratitude

The skill standards information needed to go through several iterations throughout the course of the project. The institutions and organizations listed here were extremely helpful in our efforts to accomplish this important work. To them we express our sincere gratitude and say Thank You!

Wisconsin Technical College System	WI	Salt Lake Community Collge	UT
Waukesha County Technical College	WI	Hagerstown Junior College	MD
Walsh College	MI	Grand Rapids Commnunity College	MI
Valencia Community College	FL	Oakland Community College	MI
University Of Wisconsin-Extension	WI	Macomb Community College	MI
University Of Waterloo	CAN	Oakland Community College	MI
Univ Of New Orleans Bus Ed Counc.	LA	Schoolcraft College	MI
Trident Technical College	SC	Rochester Institute Of Technology	NY
The Bevill Ctr/Gadsden St.	AL	Onondaga Community College	NY
Texas State Technical College	TX	East Tennessee State University	TN
Springfield Technical Community Coll	MA	Old Dominion University	VA
SW PA IRC/Western PA MEP	PA	Houston Community College System	TX
Southern Maine Technical College	ME	Jackson Community College	MI
Sinclair Community College	OH	Grand Rapids Community College	MI
Schoolcraft College	MI	St. Louis Community College	MO
New Hampshire Technical Colleges	NH	East Carolina University	NC
Milwaukee Area Technical College	WI	East Carolina Manufacturing	NC
Mid America Mfg Technology Ctr	KS	W.V. University Parkersburg	WV
Mercer County Tech Education Ctr	WV	Chattanooga Tech. Comm. College	TN
MANTEC, Inc.	PA	Rock Valley College	IL
Joliet Junior College	IL	University Of Missouri/Rylla	MO
Jackson Area Mfg Academy	MI	University Of Hawaii Comm College	HI
Itawamba Community College	MS	Mississippi State Univerisity	MS
Honolulu Community College	HI	Michigan State University	MI
Hagerstown Junior College	MD	Des Moines Area Community College	IA
Grand Valley State University	MI	Northhampton Commuity College	PA
Fashion Institute Of Technology	NY	Texas State Technical College-Amarillo	TX
EMPF	IN	Northwestern Michigan College	MI
El Paso Community College	TX	SoWestern Penn Ind Resource Ctr	PA
Des Moines Area Community College	IA	University Of South Carolina	SC
Delaware Valley Industrial Resource Ctr.	PA	Weber State University	UT
Cuyahoga Community College	OH	Kalamazoo Valley Community College	MI
CORD	TX	New Hampshire Technical Institute	NH
College Of The Mainland	TX	Grand Rapids Community College	MI
Camden County College	NJ	Dallas County Comm College District	TX

Recognizing Significant Contribution

With the assistance of these companies, and others like them, we have been able to gain the employer perspective on skill standards. They were also more than gracious by providing support for their workers to participate in the project. The involvement of these firms, and the investment of their time and resources was critical to the success of the project.

3M Company IA
Abex NWL Aerospace MI
AC Delco Systems NY
Acuson CA
ADI Group Inc WI
AE Goetze MN
AE Goetze-Wausau WI
Airmar Technology Corp NH
Alcoa Aluminum OH
Allison Transmission GM IN
Allmand Associates MI
Alpha Plastics MO
American Cyanamid NJ
American Tool Companies ME
Ameron PPD CA
Ames Co WV
AMI Metals Inc. CA
Amoco Oil Company TX
Amoco Petroleum Products TX
Artisan Mold MI
Asmat Inc NY
Atwood Mobile Products IL
Automotive Industries Shenanda IN
AVX Corporation SC
Balderson Inc OR
Barnes International Inc IL
Batte Inc MI
Bausch & Lomb NY
Bellwright Industries SC
Ben Mer Manufacturing NY
BF Goodrich Aerospace WV
Bitrek Corporation PA
Boeing Portland OR
Brackett and Cochran Manufacturing Inc. SC
Bridgeport Machines Inc IL
Burelbach Industries OR
Cadillac Gage Textron OH
Carrier Air Conditioning NY
Caterpillar Inc IL
Cerrn Wire and Cable Co Inc UT
Chromalox UT
Chrysler New Castle IN
Cin Made Corp OH
Clark Manufacturing MI
Clemson Apparel Research IA
Climax Portable Machine Tools OR
Cline Tool & Svc IA
CMI Cast Parts Inc MI
College of the Mainland TX
Cone Drive Textron MI
Conseco Inc IN
Consolidated Papers Inc. WI
Contico International MO
Control Devices Inc. ME
Copper and Brass Sales IN
Corbin Ltd KY
Corning Costar Corp. ME
Corning, Inc. NY
Courtaulds Aerospace CA
Crucam Inc MI
CSTCC TN
Curd Enterprises SC
Custom Machine MD
Delphi Automotive Systems NY
Delphi Energy & Engine Management NY
Devilbiss Air Power Co TN
Digital Audio Disc Corporation IN
Donlee Technologies, Inc. PA
Donsco Inc PA
Dura Automotive Systems MI

Eastman Kodak Co NY
Eaton Corporation WI
Ecco Industries Inc IL
Eldon Tool and Extrusions MI
Electromet Corp MD
Eli Lilly and Company IN
Everest & Jennings MO
Fel Pro Inc IL
Fel Pro Inc IL
Ford Motor Co MI
Friesen Products/Convertpac OR
FSM Precision Manufacturing Inc. OR
Furnas Electric Co IL
GE Fanuc N/A VA
General Devices IN
General Electric TN
General Fabricating Services PA
Gilbarco Inc NC
Good Humor Breyers Ice Cream MD
Goodwill Industries Internatio MD
Goodyear Tire and Rubber Co OH
Grand Traverse Stamping MI
Grede Foundries Inc. MI
Green Leaf Co IN
Greencastle Metal Works PA
Greenfield Die MI
Harley-Davidson Inc. WI
Harris Corporation RF Communications NY
Harsco PA
Hawtal Whiting MI
Hayes Mfg. Inc. MI
Header Die & Tool Inc IL
Heat Exchange PA
Hercules UT
Hewlett Packard OR
High Technology of Rochester NY
Honeywell Environmental Air In MD
Hurco Industries UT
Huges Space & Comm CA
Hy-Tech Mfg. WI
IBM NY
ICON Pro Form UT
Ingersoll Cutting Tool IL
Ingersoll Milling and Maching Company IL
Intermeiro Industries Inc. CA
International Imaging Material NY
International Paper Erie PA
Iomega Corporation UT
ISI Robotics MI
ITT Automotive NY
ITW Anchor Stampings CT
James River Corp. WI
John Deere Horicon Works WI
Johnson Controls WI
Kieffer and Co. Inc. WI
Kilbourne Machine Shop KY
Kirkle KS
"KMW, Inc. OR"
KR Engineering Services Inc MI
Kreinik Mfg Co Inc WV
Layton Mfg Co Inc OR
Lederle Labs American Home Products NY
Leeson Electric Corporation WI
Libbey Owens Ford IN
Link Mfg IA
LL Bean Inc. Manufacturing Div ME
LRA St Louis MO
Lydall NH
M.C. Assembly and Test FL
Mack Trucks Inc MD
Maid Bess Corporation VA
Mallinckrodt Medical MO
Markem Corp NH
Marquette University WI
Mascotech Stamping MI
MATC WI
McDonnell Douglas MO
Mechanical Industries WI
Merico Inc IN
Microelectronic Modules Corp. WI
Miles Inc. SC
Milwaukee Area Technical College WI
Milwaukee Public Schools WI
Modern Forge Tennessee TN
Monsanto IA
Morley Candy Makeers MI
Morton International UT
Mosinee Papers WI
Mr Casuals VA
MWI Inc NY
Nationwide Precision Products Corp NY
Naval Air Warfare Center CA
Neenah Paper WI
Net Shapes, Inc. CA

New Venture Gear Inc. MI
Newport News Shipbuilding VA
NewStream Enterprises MO
Newton MFG Co IA
Nichols Portland-Parker Hannifin Corp. ME
Niobrara Engineering and Research Co. InMI
NL Industries & Hughes Aircraf TX
Norco of Michigan MI
Norton Company MA
Olin-Winchester KS
Omron IL
Oregon Composites Inc OR
Oshkosh B Gosh TN
OSI Specialties WV
Osram Sylvania NH
Outokumpu Copper Kenosha WI
Packing Corporation of America WI
Parker Hannifin UT
Pella Corporation IA
Petco Frialator Inc NH
Pettibone Michigan MI
Picker Corp OH
Picker International OH
Picker X Ray OH
Pitco Frialator Inc NH
Pitney Bowes CT
Pjauter Maag Cutting tools IL
Porter Cable TN
Praegitzer Industries OR
Pratt & Whitney ME
Precision Group, Inc. IL
Procter & Gamble Mfg MO
Professional Manufacturing Inc UT
Qualitor Corporation NY
Raskab Dairy Inc. MO
Raskas Cheese Products of PA PA
Redcom Laboratories Inc NY
Regal Plastics MI
Regal Ware Inc. WI
Rhinelander Paper Company WI
RIT CIMS NY
RJF International OH
Robert Bosch Corp. SC
Rock Valley College IL
Rockford Manufacturing Group Inc. IL
Rockford Process Control Inc. IL
Rockford Spring Co IL
Rockwell International IA
Rogers Associates Tool and Die Corp NY
RSG Technologies Inc MI
Saco Defense Inc. ME
Salter Labs CA
Sauer Sundstrand IA
Schatt Scientific Glass Inc WV
Scott Metals PA
Sears Manufacturing Co. IA
SP Sheffer Fizzie International MI
SRC (Newstream) MO
Stackhouse Athletic Equipment OR
Stackpole Limited USA TN
Stebbins Lumber MI
"Tech Sew Manufacturing, Inc. NY"
Teledyne Specialty Equipment PA
Texas Instruments TX
The ESAB Group PA
The Gates Rubber Company SC
The Goodyear Tire and Rubber Co. WI
The Hubert Group MI
The Pangborn Corportation MD
The Standard Products Co OH
Thombert Inc IA
Tool All Inc PA
Tool North Inc. MI
Tooling and Equipment Internat MI
Touchstone Inc TN
TPI Corp TN
Trident Tool Co NY
Union Carbide Corporation TX
United Technologies Carrier IN
Univ of Wisconsin Extension WI
Vermeer Mfg. IA
Watlow AOV, Inc. CA
Watlow Electric MO
Waukesha Engine Dresser WI
Wellhead Inc. CA
Welliver Metal Products Corp OR
Wells Cargo Inc. UT
West Salem Machinery Co OR
Westview Products Inc OR
Williamson Dickif TX
Woodward Governer Company IL
Xerox Corporation NY

Special Thanks

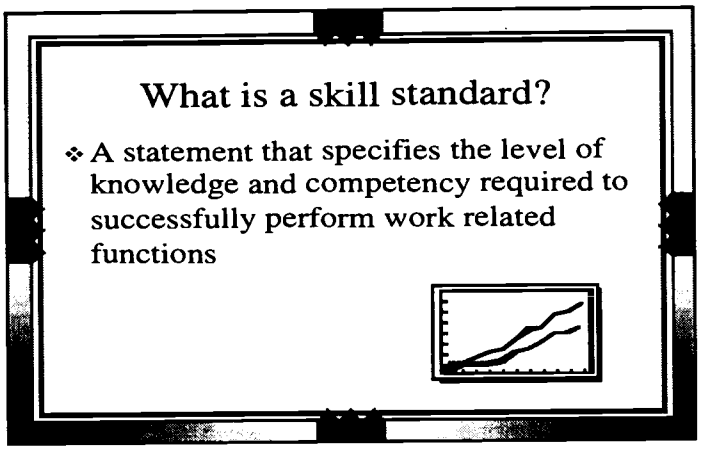
The strength and success of this project is based on the work, time and critical input provided by manufacturing workers who are the most valid source of information. In addition to being manufacturing workers, many of the individuals who provided us with information also are parents and students themselves. This helped us to look at and validate skill standards from those equally important perspectives.

The organizations and companies previously mentioned facilitated the process of including these workers, and offered their own insights as well. But, the direct input from manufacturing workers provided the substance for this project and report. In the course of this project we have received detailed information representing more than 5000 manufacturing workers across the country. To those individuals we extend our special thanks and sincere appreciation for their help.

Appendix A

Skill Standards Framework

To accomplish the goal of communicating skill standards information clearly and effectively, there needs to be a consistent framework/format that includes all of the information necessary to form a standard. We have identified the following elements to be part of each skill standard. This is based on our own research and considerable work done by other local, state, and national skill standards projects, as well as current best-practice in the education and training community. We have given our best effort to incorporate the needs of the various audiences that will be using the standards: current workers, employers, students, teachers, parents, and community representatives.



A standard for a specific skill should contain the following five elements:

1. What is the action (skill)?
2. What are the conditions under which the action is performed? (e.g. alone or group)
3. How good is good enough? (criteria/measure)
4. How will the action be measured? (portfolio/test/observation)
5. Why must the action be performed? (context/rationale)

An example of a skill standard is:

Working alone with a calculator, add 10 two or three digit numbers five times in three minutes with 100% accuracy, in order to perform necessary calculations for Statistical Process Control (SPC) during the manufacturing process. The successful demonstration of this skill is to be documented by third party or performance assessment.

This example includes:

Action: *add 10 two or three digit numbers*
Conditions: *Working alone with the use of a calculator...five times in three minutes*
How good is good enough: *100% accuracy*
Why: *in order to perform necessary calculations for Statistical Process Control (SPC) during the manufacturing process.*
How is it measured & documented: third party evaluation or performance assessment

Definitions:

Skill - Proficiency, facility, or dexterity that is acquired or developed through training or experience; the ability to do something well; expertness or dexterity in performance.

Standard - an acknowledged measure of comparison for quantitative or qualitative value; a criterion; an object that under specified conditions defines, represents, or records the magnitude of a unit; something accepted as a basis of comparison; usual or customary.

Knowledge - the state or fact of knowing; familiarity, awareness, or understanding gained through study or experience; something that is or may be known

Competent(cy) - having suitable skill, experience, etc., for some purpose; ability to perform a task effectively and efficiently; stated in measurable, observable terms.

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement (OERI)
Educational Resources Information Center (ERIC)

NOTICE

REPRODUCTION BASIS

☐ This document is covered by a signed "Reproduction Release (Blanket)" form (on file within the ERIC system), encompassing all or classes of documents from its source organization and, therefore, does not require a "Specific Document" Release form.

☑ This document is Federally-funded, or carries its own permission to reproduce, or is otherwise in the public domain and, therefore, may be reproduced by ERIC without a signed Reproduction Release form (either "Specific Document" or "Blanket").