DOCUMENT RESUME

ED 397 251 CE 072 076

| | |
|---|---|
| TITLE | Partnership To Pave the International Information Highway. |
| INSTITUTION | Eastfield Coll., Mesquite, TX. |
| SPONS AGENCY | Texas Higher Education Coordinating Board, Austin. Community Colleges and Technical Institutes Div. |
| PUB DATE | 95 |
| CONTRACT | 55130005 |
| NOTE | 266p.; Prepared by Partners in Profound Knowledge. |
| PUB TYPE | Reports - Research/Technical (143) |
| EDRS PRICE | MF01/PC11 Plus Postage. |
| DESCRIPTORS | Academic Standards; Community Colleges; Comparative Analysis; Curriculum Development; Definitions; *Educational Needs; *Electronic Equipment; *Employment Qualifications; *Equipment Manufacturers; *Foreign Countries; International Organizations; Job Skills; Manufacturing Industry; Material Development; Needs Assessment; Statewide Planning; *Technology Education; Telecommunications; Two Year Colleges |
| IDENTIFIERS | American National Standards Institute; Canada; DACUM Process; International Standards; Mexico; Secretarys Comm on Achieving Necessary Skills; *Texas; United States |

ABSTRACT

Eastfield Community College (ECC) of Texas' Dallas Community College District obtained funding to examine the current skill standards for the job training of telecommunication manufacturing production specialists. Together with the firm Partners in Profound Knowledge (PPK), ECC documented and compared the skill standards required for telecommunication manufacturing production specialists in the United States, Canada, and Mexico and prepared reports outlining the new skills required in community college-level telecommunications programs, the basic and Secretary's Commission on Achieving Necessary Skills (SCANS) skills for the three countries, and the results of the skill analysis study. During the project, 139 skill standards were developed for the occupation of general electronic technician and recommendations were formulated regarding developing/updating curricula reflecting international standards at community colleges throughout Texas. Appendixes constituting approximately 60% of this document contain the following: PPK's proposal to assist ECC; the 139 skill standards developed by the partners for the occupation of general electronics technician; an American Society for Quality Control publication devoted to applying American National Standards Institute standards to education and training institutions; and an excerpt from the SCANS report, "Learning a Living: A Blueprint for Higher Performance." Contains 13 references. (MN)

# Eastfield College

3737 Motley Dr., Mesquite, Texas 75150

# Partnership to Pave the International Information Highway



Grant #55130005



A Carl Perkins Project Funded by the Texas Higher Education Coordinating Board

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and

Executive Summary

# INTERNATIONAL SKILLS STANDARDS FOR THE TELECOMMUNICATIONS MANUFACTURING PRODUCTION SPECIALIST

**Prepared by:**

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**in cooperation with**

**Eastfield College**
**Dallas County Community College District**

## Executive Summary

Eastfield Community College of the Dallas Community College District obtained funding to document and compare the current skill standards for the job preparation of a telecommunication manufacturing production specialist. The fundamental purpose of the project is to create an outline that can be used by the technology and occupation programs of community colleges in Texas to develop a curriculum to prepare telecommunications manufacturing production specialists.

It should be noted at the outset that the focus of the work by Eastfield College has been about addressing their, and through them other community colleges, responsibilities for the way work is organized, how the teaching of the work is arranged and the development of the human resources in the college, the community, and the state. Eastfield College is not interested in being a trade school; rather, they are committed to fulfill the charge stated in the first SCANS report: "A solid education is its own reward and has value beyond specific skill."

It is important that in the pursuit of the above statement that students exiting the preparation program in the community colleges of Texas have a solid foundation, but a solid foundation is not enough. More important, these students need to learn how to conceptualize problems and solutions. The formal education of the telecommunications manufacturing production specialist will also entail refining four basic skills: abstraction, systems thinking, experimentation, and collaboration. These are all cited in various parts of the SCANS competencies. The capacity for abstraction entails the discovery of patterns and meanings through which reality can be understood and applied in new ways. Students need to learn

to examine reality from many angles, in different lights, and visualize new possibilities and choices.

Systems thinking, which is a key point of the SCANS emphasis, is seeing reality as a system of causes and consequences. To discover new opportunities, one must be capable of seeing the whole and of understanding the processes by which parts of reality are linked together. It should be noted that in the real world of work the issues to be faced rarely emerge clearly defined and separated into neat categories.

The third aspect of the higher order of abstraction and system thinking is experimentation. Experimentation in this context is defined as use of the Plan-Do-Study-Act (PDSA) cycle for continual improvement. The habits and methods of continual improvement, or process improvement, are critical in the new economy, where constant flux is the norm for technologies, tastes, and markets. Understanding and practicing the quality sciences and process improvement concepts and tools equip students with a new foundation for finding their own way. More important, students are taught to accept responsibility for their own learning. If education is truly committed to "life-long learning," or "learning a living," as it is called in the SCANS report, this will be critical.

Finally, if there is to be high performance in the work place, as called for in the SCANS report, the student must possess the capacity to collaborate, communicate abstract concepts, and achieve a consensus; traits which are not usually emphasized within formal education. Yet, this is the greatest need cited in interviews with business and industry, and it is usually called teamwork. Self-

managing teams, high production teams, and self-directed work teams are some of the terms used to express this need.

Students who can meet these requirements of business and industry will practice critical thinking and can articulate, clarify, and then restate , each another how they identify and find answers. They know how to seek and accept criticism from peers, solicit help, and give credit to others (i.e., work with diversity). They can negotiate or explain their own needs, discern what others need, and view things from other's perspectives, in order to discover mutually beneficial resolutions.

In conclusion, management of the community college vocational and technical system need:

- to identify the content and quality systems elements of education/training for the telecommunications manufacturing production specialist process and curriculum
- to assure the capacity of the personnel required to teach/train for the program
- to meet customer requirements (there are several customers to be considered in this system)
- to audit the telecommunications manufacturing production specialist education/training programs.

Specified management representatives need:

- to relate the telecommunications manufacturing production specialist training to the ISO (Z-1.11) elements
- to be familiar with auditors' interpretation of ISO 9001 elements
- to assure compliance of education/training with existing law
- to define assessment criteria for deliverables in the telecommunications manufacturing production specialist process

Education/Training Suppliers need:

- to measure internal customer satisfaction
- to manage the quality control of education/training
- to define competency criteria for educators/trainers
- to measure education/training effectiveness and evaluate effectiveness of the education/training provided
- to monitor the improvement of the education/training process

This report provides information and recommendations for the community colleges of Texas. Each institution must decide what resources will be allocated and steps will be taken to create a system that will meet its specific goals. But first, as the SCANS report so notes, "each must become involved in a conversation about its place in a fast changing world as we approach the year 2000."

Motivation of personnel begins with their understanding of the tasks they are expected to perform and how those tasks support the overall activities. Educators should be made aware of the advantageous effects of proper job performance at all levels, and of the effects of poor job performance on other educators, student learning, student/employer satisfaction, and the well-being of the institution, the image of the institution, and the companies they serve.

The community college system is the most viable link the community has in the retraining of the workforce needed to keep pace with the ever-changing business and technology demands. Certainly the major concern of administration of these systems is to continue to thrive in a systematic and cost-effective approach to excellence in community colleges. Modeling Z-1.11 leadership would demonstrate

that workplace know-how called for in the area of systems:..."they can monitor and correct performance; and they can design or improve systems." A copy of the Z-1.11 document is attached as Appendix D for review and consideration.

Any Texas community college wishing to effectively provide a quality curriculum for a telecommunications manufacturing production specialist or electronics technician would benefit greatly from the following six recommendations:

1. Compare the work of the DACUM to the curriculum currently in place at their community college and note major areas of difference or deficiency. Work continuously to bring the former curriculum in line with the desired DACUM.
2. Use every opportunity to instill workplace know-how (the SCANS foundations and workplace competencies) and critical thinking skills into the entire continuum of community college education. Critical thinking is defined as clarity of thought, accuracy of thought, and fairness of thought.
3. In realigning curriculum, in order to prevent duplication of effort and thus creating waste, consider the work done by the Texas Education Articulation Model (TEAM) Consortium and the Emerging Skills Standards for the Electronics Industries Association. Both of these groups have done extensive work that will be profitable to the community colleges in Texas. Also consideration should be given to cooperating with the Statistics Division of the American Society for Quality Control (ASQC). The Statistics Division of ASQC has formed a subcommittee to work on "integrating statistical thinking into all educational curricula." "Statistical thinking," as used by the Statistics Division, refers to those thought processes that recognize that:

- All work occurs in a system of interconnected processes, each of which has customers.
- Variation exists in all processes.
- Causes of variation can be loosely segregated into "common" and "special" causes.
- Understanding the unique nature of both common and special causes is the key to reducing variation.
- Reducing variation is the key to improving quality, productivity, and profitability.

The Statistics Division is currently looking for educational organizations to work with members of their subcommittee to assist organizations in transforming from their current method of operation into one of continuous improvement throughout the entire organization. They are attempting to build case studies in education where such transformations have occurred and have been successful.

4. In interviews with the educational delivery providers, the lack of knowledge about the important aspects of quality is startling. Even the DACUM notes safety and quality at the end of the process rather than at the front end and of utmost importance to the process. Certainly the vocational and technical programs are a key place to start this type of "quality" thinking.
5. Apply process improvement concepts and tools to master the processes involved in working through the desired curriculum changes and/or additions with respect to only the telecommunications manufacturing productions specialist using the Plan - Do - Study - Act cycle. Then use the same approach to obtain the same

desired transformation to other academic areas in the community college curriculum.

6. Implement a better selection process for students wishing to participate in the "telecommunications manufacturing production specialist" or "electronics technician" program. Currently, the comparison of the DACUM skills shows that skill FC12 (Electro-Mechanical Aptitude - see section 3, page 6, Figure 2) does not align with the SCANS skills. Since aptitude means "natural disposition or tendency," it is possible for a student to enter the program without this aptitude and could, consequently, not be able to perform at the desired level of competency. In short, the student's selection to enter the program is self selection. A level of screening should be developed that would assure that all students entering the program would possess a minimum level of electro-mechanical aptitude.

# International Skills Standards for The Telecommunications Manufacturing Production Specialist

## Introduction

Educational standards are critical to America's global competitiveness. Eastfield College believes that they have an obligation to know and apply the latest standards and practices of industry when preparing students for employment. This commitment requires constant attention to the skill standardization process. Community colleges should know about and participate in developing voluntary standards for products, technical needs, and services.

Skills standards advocate the educating of customers about standards and standards issues. Meeting the requirements of product standards in manufacturing requires workers to have increasing levels of technical and workplace skills. Consequently, the old practices of hoping that industry can train new workers to overcome their weaknesses are costly and impractical. Educational training is improving; however, the modern workplace demands exponential improvements. Industry-defined skill standards and a skills certification system should result in better educational and training programs and better prepared employees for business.

Community college technology and occupational programs should realize direct benefits from standards-based programs. The internal work of the institution should be simplified, in turn creating a more uniform and effective environment in which to work. Externally, such programs should add credibility to their graduates and enhance relationships with their customers by avoiding the pitfalls of nonstandard practices. Eastfield College believes that educational professionals have the responsibility to help their customers make informed decisions. Ultimately, the customers will be benefactors, as will all community colleges.

**Statement Of Goals And Objectives**

1. Create an outline that can be used by the technology and occupational programs of community colleges to develop a curriculum for the preparation of telecommunications manufacturing production specialists.
    1.1 Determine the current skill standards for a telecommunication manufacturing production specialist.
    1.2 Create a procedure to partner with industry.
    1.3 Develop a process for standards development.
2. Determine the current skill standards for the preparation of a telecommunication manufacturing production specialist.
    2.1 Use the DACUM information provided by Eastfield College as a baseline to benchmark and compare the current standards and requirements for a telecommunications manufacturing production specialist, or equivalent, in other parts of the USA, Canada, and Mexico.
        2.1.1 Document the standards for a telecommunications manufacturing production specialist in the USA, Canada, and Mexico.
        2.1.2 Create a matrix showing commonality and voids between the USA, Canada, and Mexico.
3. Compare the findings of 2.1 with the international standards of the telecommunications industry (the definition of international standards used here is the work being done under the coordination of ISO).
4. Prepare a report on the new skills needed for the curricula at community colleges.

The outcome is a documented comparison of community colleges and technical colleges in Texas with a detailed plan for enhancing partnerships with

business. A step by step outline for establishing industry-based skill standards and the framework to modify existing curricula, or develop new curricula, will be produced for a telecommunications technician program. Workers produced by such programs should be properly trained for the international market place involving USA, Canada, and Mexico.

**Tasks for Partners in Profound Knowledge**

Since Partners In Profound Knowledge (PPK) shares the commitment and beliefs held by Eastfield College, they will assist in fulfilling the grant objective of "partnership to pave the international information highway." The goal of the project is to establish a partnership to define standards in both basic concepts and technical skills which will ensure that telecommunication technology training programs that adhere to those standards will train and certify workers who possess the necessary skills to effectively help companies compete in the international market place. Specifically, PPK will provide information for developing a framework to update existing curricula, or develop new curricula, for a telecommunications manufacturing specialist program that will produce such workers. The specific areas of responsibility proposed for accomplishment by PPK (See Attachment A) are:

- Document the skills standards required for the USA, Canada, and Mexico
- Create a matrix of commonalty and voids of skills for the three countries
- Compare the telecommunications program competencies with the international skills requirements
- Prepare a report outlining new skills required in the telecommunications program
- Prepare a report outlining the basic and SCANS skills for the three countries

- Prepare a report on the results of the skill analysis study
- Prepare a final report

The specific objectives, activities, and tasks, listed in Attachment A, are identified in Figure 1 for the respective areas of responsibility assigned to PPK.

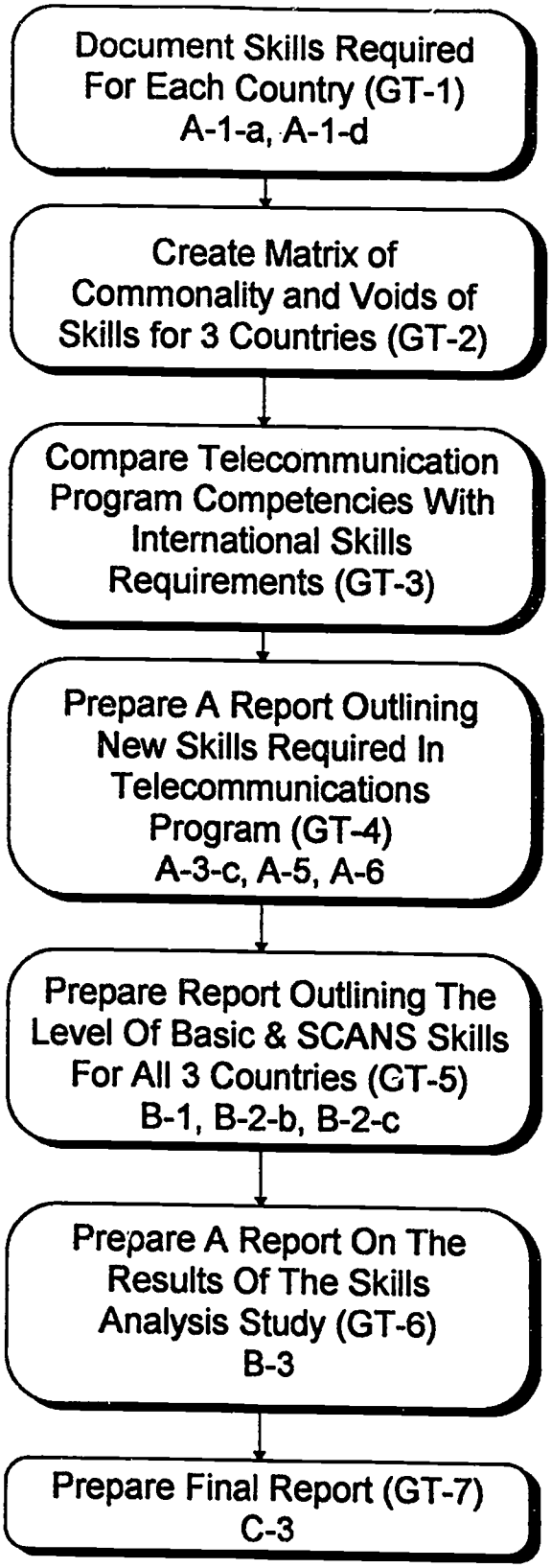
Document Skills Required For Each Country (GT-1) A-1-a, A-1-d
Create Matrix of Commonality and Voids of Skills for 3 Countries (GT-2)
Compare Telecommunication Program Competencies With International Skills Requirements (GT-3)
Prepare A Report Outlining New Skills Required In Telecommunications Program (GT-4) A-3-c, A-5, A-6
Prepare Report Outlining The Level Of Basic & SCANS Skills For All 3 Countries (GT-5) B-1, B-2-b, B-2-c
Prepare A Report On The Results Of The Skills Analysis Study (GT-6) B-3
Prepare Final Report (GT-7) C-3

**Figure 1**

**Standards and Skill Standards Defined**

"A standard is a prescribed set of rules, conditions, or requirements, concerned with the definition of terms; classification of components; delineation of procedures; specification of dimension, materials, performance, design, or operations; measurement of quality and quantity in describing materials, products, systems, services, or practices; or descriptions of fit and measurement of size" (OMB Circular A-119, 1982). Again, meeting product standards requires workers with increasing levels of technical and workplace skills. However, the word "standards" elicits strong emotional response from educators. Education is beginning to understand that standards are more than the evaluative standards that are so pervasive in academia. Education is slowly improving and, with a better understanding of standards, will reach higher levels. However, the modern workplace demands faster and greater improvement now. The collaboration between industry-defined skill standards and a skill certification educational system will result in results-based education and meet the demand for a competitive advantage for business and industry.

The word "standard" carries many meanings. Some examples of various definitions are as follows:

1. "An agreed way of doing things" (Cavanaugh, 1977:12);
2. "Standards are courses of action selected by organizational management from many alternatives to which the managed must conform in order to achieve the desired, forecast results with the least expense and time" (Gile 1972:33).
3. "A standard is, in addition to a carefully worded description, a result of evaluation, coordination, elimination, selection, decision making, and enforcement (Gile, 1972:31).

A prime consideration for community colleges comes from the view expressed by Davis, "An institution's goals and objectives may grow out of a highly conservative tradition (such as 'great books') or a technology-oriented approach (like PLATO), which can have profound implications for...programs...the program cannot be expected to effectively carry out its mission unless it has certain levels of service, equipment, materials, facilities, staff, and funding–in other words, STANDARDS" (Davis, 1979: 13).

Standards fall into one of three classes: voluntary, voluntary consensus, or mandated (i.e., imposed.) Most of the standards used in organizations are mandated or imposed by those above upon those below. The higher performing standards are those which have had input from, or have been developed by, those who actually do the work. Definitions of voluntary, voluntary consensus, and mandated standards are:

- A voluntary standard is developed either through a full democratic, consensus process, or through a process that does not fulfill all the democratic, consensus requirements. However, it is not voluntary in the sense that its development and use within various segments of society are voluntary.

  (Walser, 1989)

- A voluntary consensus standard is both voluntary in its development and in its use, and in addition, the developers of the standard must have adhered to and complied with a documented, democratic, consensus developing management process in its formation.

  (Walser, 1989)

- A mandated or imposed standard may have originated from a voluntary or a voluntary consensus standard and, through a legal or legislative process, become a law, regulation, code or court order. However, many mandated or imposed standards do not trace their origins back to voluntary standards

processes, but were produced by individuals or groups through a system or systems that did not necessarily fulfill an open voluntary, democratic consensus process.

(Walser, 1989)

Standards that focus on the targets of standardization rather than focusing on the process or on the group are:

Object Standards: describe and define objects or natural phenomena such as weights and measures.

Documentary Standards: address issues such as definitions, classifications, recommended practices, specifications, test methods, and codes.

Conceptual Standards: target issues encouraged in social areas such as customs, traditions, and behavioral norms.

(Verman and Visvesvaraya, 1977); (Cerni, 1984)

The American Society for Testing and Materials notes six types of full consensus standards. They are:

Standard Test Method: a definitive procedure for the identification, measurement, and evaluation of one or more qualities, characteristics, or properties of a material, product, system, or service that produces a test result.

Standard Specification: a precise statement of a set of requirements to be satisfied by a material, product, system, or service that also indicates the procedures for determining whether each of the requirements is satisfied.

| | |
|---|---|
| Standard Practice: | a definitive procedure for performing one or more specific operations or functions that does not produce a test result. |
| Standard Terminology: | a definition or description of terms, or explanation of symbols, abbreviations, or acronyms. |
| Standard Guide: | offers a series of options or instructions but does not recommend a specific course of action. |
| Standard Classification: | a systematic arrangement or division of materials, products, systems, or services into groups based on similar characteristics such as origin, composition, properties, or use. |

(From 20 Questions About ASTM)

Standards are also viewed from a perspective of organizational applicability. For instance, there are four commonly accepted delineations in this area. They are:

| | |
|---|---|
| Company Standards: | consensus being among the employees (principally within such departments as design, development, production, and purchasing) of a given organization. |
| Industry Standards: | consensus being among the companies within a given industry (typically developed by a trade association). |
| Professional Standard: | consensus being among the individual members of a given profession (typically developed by a professional society). |
| Government Standards: | consensus often being among the employees of a governmental agency or department. |

(From 20 Questions About ASTM)

These delineations affect specific sectors in business and industry, such as the electronics and telecommunications industries. In this report, specific types of standards will be cited when it is important to do so; however, when no definition reference is made, the term standard may include all of the definitions above.

Standards can add value to the education service industry since the principles of industrial standards are applicable to education. The product of education is the people that industry hires, and the better they think, the better it is for industry. Creativity is the most important aspect of making a company successful. Yet, one of the blocks to the standardization effort in education is the difference in the language of educators and the language of business and industry. Dr. William Golomski, University of Chicago, notes, "The language we choose in our discourse is very important in our determination of reality. Thus, we need standards of terminology."

In the past, most of the standards developed were for products. Currently, standards development is focusing on both production and service. Education is a service which should be producing workers possessing the workplace know-how identified by SCANS. The know-how identified in SCANS consists of five competencies and a three-part foundation of skills and personal qualities that are needed for a solid job performance. The questions which must drive the development of educational standards are: Where have we been?; Where are we now?; and Where do we want to go?

Importance of the Community College Effort:

The International Standards Organization (ISO) is currently in the midst of drafting long-range strategies for the 1996-1999 time frame. ISO envisions that

as we approach the 21st century the world will be one in which global trade between nations will continue to grow at a rate 3 to 4 times faster than national economies. ISO believes that this will be a world in which the designing, manufacturing, marketing, and servicing operations of a majority of individual enterprises will be distributed across many countries. This is also projected to be a world in which electronic communications will dramatically enhance the technical collaborations between experts in academia, governments, and industries from all countries.

ISO cautions that the increasingly rapid development of technology and its support system will continue to present underlying dangers as well as major opportunities for the general welfare of society. It will, therefore, be incumbent on all social and economic partners, including community college districts, to collaborate closely in guiding the applications of appropriate technologies toward sustainable economic development and global prosperity. The location of the Secretariat of the NAFTA Commission for Labor Cooperation in Dallas provides an excellent opportunity for such participation. This Secretariat will implement and monitor labor provisions of the NAFTA.

In this rapidly evolving scenario, global standards will play a key role. Such standards, whether developed by the telecommunications technology programs at community colleges, the Electronic Industries Association, ISO, or others, will become primary technical instruments supporting international commerce. It is in this context that ISO intends to be recognized globally as an influential and innovative leader in the development of international standards.

The telecommunications technology programs at community colleges should note that ISO strives to apply consensus and transparency principles in standardization. In this way, they promote the values of rationality, utility, safety, and environmental protection for the benefit of everyone.

With increasing emphasis on free and open international trade in the service industries (education, finance, tourism, insurance, etc.), the need for international standards are felt more strongly than ever before. The newly established World Trade Organization (WTO) will administer the GATT agreements of the Uruguay Round (1994). These agreements include a new GATT Code on Technical Barriers to Trade (The GATT Standards Code) and significantly expand the scope of GATT into the services sector. For the community colleges, this need represents an opportunity to extend their standards development efforts into some new areas.

**Skills Standards for Canada**

On May 17, 1995 after several referrals from other persons, Dr. LeRoy Walser interviewed Ajmer Bal, Canadian Standards Association, regarding the Canadian use of skills standards in electronic and telecommunications manufacturing. Mr. Bal's analysis was that Canada has not yet initiated any coordinated effort in this area. They rely for their latest information on participation in the fast-changing international voluntary standardization activities which are continually developing and revising technical and product standards for the electronic and telecommunications industries. Mr. Bal noted that workers are expected to have a fundamental knowledge, but he acknowledged that the fundamental knowledge of the past was not sufficient for the current global economic environment.

Mr. Bal strongly emphasized the point that students and trainees should be taught standards and standardization in the schools. He was very adamant that this is where it belongs. He is of the opinion that too many workers do not understand their jobs. He added that this lack of knowledge of either the process used for developing standards or the standards themselves constitutes some of the major stumbling points for people being prepared to either go to work or currently working in electronics and telecommunications manufacturing. Canada depends on two major international associations for guidance and material support in the standards area. Those are the Electronic Industry Association (EIA) and the Telecommunications Industry Association (TIA).

**Skills Standards for Mexico**

Dr. Walser contacted Victor Lopez, former official of Telefonos de Mexico, to inquire about Mexico's use of skills standards for training workers in the telecommunications industry. Mexico is not yet to the point of manufacturing products and is importing the electronics equipment and materials used in their telecommunications activities from other countries. Their training is geared mainly toward installation, maintenance, and repair.

**Skills Standards for AT&T - Oklahoma City Works**

On May 10, 1995 Dr. LeRoy Walser interviewed Gaye Stallings, Frank Niewinski, and Robert Cooper of AT&T Oklahoma City Works (OKC Works). OKC Works manufactures and repairs telecommunications switching devices and related products. Their approach for training is from general to specific. In working that approach, they have discovered some significant areas where people being employed as telecommunications manufacturing specialists were not well prepared. Highlights are as follows:

1. Computer Literacy: This is an essential. The major machine used in their manufacturing process is FUJI built and operates using the "Windows" format. Students must have a solid base in using computers and must be able to use Windows for modifying programs for individual machine control. They must know keyboarding and general operations, how to use machinery and equipment, and how to manage a machine line.

2. Soldering: OKC Works uses the ASTM or ANSI standard for soldering and finds that most of their new hires are not familiar with this process. They need the concept of quality as applied to the soldering standards.

3. Surface Mounting: New employees should understand the systems approach to manufacturing. The systems approach includes the flow of products and the manufacture and/or assembly requirements. They need to understand value added and the cost that mistakes add to any process. Data show that many new workers lack experience in completing certain tasks or reading blueprints and schematic drawings. They do not realize the effect of a defect in the process.

4. Quality Systems: According to the interviewees, most new workers do not understand quality systems, total quality control (TQC), team work, and quality assessment.

- The interviewees observed that new workers:
    - do not understand electronic static discharge;
    - don't know the difference between digital and other forms of electronics;
    - are lacking in ability to read and understand drawings;
    - don't know what is required to assemble products
    - have a very limited concept of safety
    - do not understand how to use machines;
    - do not understand variation;

- do not appreciate the cost of products;

A whole new generation of training is necessary, starting with TQC. Workers need an understanding of the vast potential of the telecommunications industry and its relationship to a global economy.

Listed below are some specifics that OKC Works indicated that all new employees should know:

- Machinery: mechanical assembly, test set up, basic computer skills (Windows environment).
- Computers are used to monitor production and compute data results..
- The telecommunications industry utilizes computerized testing. Therefore, programming, networking, changing or modifying programs, adjusting coordinates, understanding metric systems, basic math, positive and negative numbers, applied algebra and trigonometry are very important.

**Skill Standards for AT&T - Mesquite**

In the spring of 1995, Celeste Guerrero, Dean of Technical Education at Eastfield College, facilitated the "Develop a Curriculum" (DACUM) process at the AT&T plant in Mesquite, Texas. The process was applied using eight panelists:

Charles Eric Anderson
Senior Manufacturing Specialist

David Finnell
Production Specialist

Bobby Hogue
Senior Production Specialist

Brenda Madison
Senior Production Specialist

Ellen Nelson
Production specialist

David Peters
Production Specialist

Kerry Ragsdill
Production Specialist

Johnny C. Rivera
Senior Production Specialist

The result was a DACUM profile for a telecommunications manufacturing production specialist. The DACUM profile is presented in Figure 2.

# DACUM Profile for Telecommunications Manufacturing Production Specialist - AT&T Mesquite

**Foundation Skills: (F)**

A. Basic Skills
1. Reading
2. Writing
3. Arithmetic & Mathematics
4. Speaking
5. Listening

B. Thinking Skills
1. Ability to Learn
2. Ability to Reason
3. Ability to Think Creatively
4. Ability to Make Decisions
5. Ability to Solve Problems

C. Personal Qualities
1. Positive Attitude
2. Safety Conscious
3. Quality Conscious
4. Drug Free
5. Self-Directed
6. Dependable
7. Ethical
8. Patient
9. Mutual Respect
10. Diversity Awareness
11. Team Work Skills
12. Electro-Mechanical Aptitude

**Workplace Competencies: (W)**

A. Allocate Resources
1. Time
2. Money
3. Materials
4. Space
5. Staff

B. Interpersonal Skills
1. Work on Teams
2. Teach Others
3. Serve Customers
4. Lead
5. Negotiate
6. Work Well With People from Culturally Diverse Backgrounds

C. Productively Use Information
1. Acquire and Evaluate Data
2. Organize and Maintain Files
3. Interpret and Communicate
4. Use Computers to Process Information

**Workplace Competencies (Continued):**

D. Systems
1. Understand Social, Organizational, and Technological Systems
2. Monitor and Correct Performance
3. Design and improve Systems

E. Productively Use Technology
1. Select Equipment and Tools
2. Apply Technology to Specific Tasks
3. Maintain and Troubleshoot Equipment

**Technical Knowledge: (T)**

1. Safety Awareness (OSHA, EPA)
2. Chemical Handling
3. Metric & Standard Conversations
4. Schedule/Planning
5. Inventory Control
6. Statistical Process Control
7. Basic Electrical Theory
8. Blueprint/Schematic Interpretation
9. Basic Management/Budgeting

**Equipment Tools: (E)**

1. Scales
2. Oscilloscopes
3. Volt-Ohm Meters
4. Probes
5. Leak Detectors (MSLD)
6. Basic Shop Tools
7. Micrometers
8. Computers
9. Travel Indicators
10. Laser Optics
11. Hydraulic Tools
12. Helium Detectors
13. Tension Indicators
14. Winches
15. Hoists
16. Cranes
17. Conveyors
18. Elect/Mech Hand Tools
19. Steel Rule Dies
20. Feeler Gauges
21. Precision Levels
22. Cutting Tools
23. Dial Indicators
24. Safety Equipment
25. Calipers
26. Staple Guns
27. Strapping Machines
28. Shrink Wrapping Machines
29. Box Openers
30. Hand Tape Dispensers
31. Pipe Fitting Tools
32. Welding/Soldering Tools

**Figure 2**

# DACUM PROFILE FOR TELECOMMUNICATIONS MANUFACTURING PRODUCTION SPECIALIST

PANELISTS:

Charles Eric Anderson
Senior Manufacturing Specialist

David Finnell
Production Specialist

Bobby Hogue
Senior Production Specialist

Brenda Madison
Senior Production Specialist

Ellen Nelson
Production Specialist

David Peters
Production Specialist

Kerry Ragsdill
Production Specialist

Johnny C. Rivera
Senior Production Specialist

FACILITATOR:

Celeste Guerrero
Dean of Technical Education
Eastfield College

**PARTNERSHIP to PAVE the INTERNATIONAL INFORMATION HIGHWAY**
**EASTFIELD COLLEGE**

**A CARL PERKINS PROJECT THROUGH**
**THE TEXAS HIGHER EDUCATION COORDINATING BOARD**

JOB TITLE: Telecommunications Manufacturing Production Specialist

JOB DESCRIPTION: A Telecommunications Manufacturing Production Specialist manufactures and repairs electronic components and equipment.

[redacted]

Dallas County Community College District

| DUTIES | TASK STATEMENTS | | | | | | |
|---|---|---|---|---|---|---|---|
| Receive Raw Materials A | Verify shipment quantity A1 | Sort materials A2 | Verify purchase order A3 | Enter data A4 | Print labels A5 | Affix labels A6 | Transport materials A7 |
| Maintain Stock B | Receive materials B1 | Verify materials B2 | Store materials B3 | Fill orders B4 | Verify material location B5 | Transport materials to central location B6 | |
| Control Storeroom Inventory C | Receive discrepancy report C1 | Verify discrepancy C2 | Define problem C3 | Solve discrepancy problem C4 | | | |
| Set Up Work Station D | Review work assignment D1 | Enter program code D2 | Prepare machines D3 | Run samples D4 | Verify sample quality D5 | Engage machine D6 | |
| Manufacture Coils E | Secure work assignments E1 | Review documentation E2 | Gather materials E3 | Wind coils E4 | Solder coils E5 | Assemble coils E6 | Test sample E7 | Verify sample quality E8 |
| Complete Magnetic Construction F | Secure production data F1 | Wind bobbins F2 | Salter bobbins F3 | Assemble bobbins F4 | Test completed bobbins F5 | Complete final inspection F6 | Pack finished product F7 | Transport materials F8 |
| Ship Finished Product G | Receive finished product G1 | Verify product count G2 | Route shipment G3 | Place shipment to correct areas G4 | Load carriers G5 | | |
| Assure Quality Control H | Gather data H1 | Interpret data H2 | Exercise authority H3 | Investigate symptoms H4 | Determine action H5 | Document decision H6 | Participate in continual improvement H7 |
| Maintain Safety Standards I | Select safety attire I1 | Check safety regulation list I2 | Clean area I3 | Inspect machine safety features I4 | Perform preventative action I5 | Attend safety training courses I6 | |

May 30, 1995

**An Emerging Standard**

The Electronic Industries Association and the Electronic Industries Foundation are currently developing a set of skill standards to measure and promote the competency of work-ready, entry-level U.S. electronics technicians. These skill standards are being developed via a cooperative effort between industry and government that began in 1991 with the Secretary's Commission on Achieving Necessary Skills (SCANS). In October, 1992, the U.S. Department of Education's Business and Education Standards Program extended the cooperation, providing to the Electronic Industries foundation (EIF) and its parent organization, the Electronic Industries Association (EIA), to initiate the National Skill Standards Development Project (NSSDP). The NSSDP, part of a national effort to improve American workplace standards by the year 2000, represents an intensive effort to identify, detail, and validate clusters of skills and competencies that the work-ready, entry-level technician needs to meet the demands of the U.S. electronics industry. An individual who can meet these standards will be able to enter the workforce and, with a minimum of additional specialized training, move into one of eleven specialty occupations: general electronics, avionics, business machine service, consumer product service, biomedicine, microcomputer systems, microcomputer systems field service, industrial electronics, instrumentation, telecommunications, and automobile service.

Developing standards that would meet the varied and compelling needs for them demanded the cooperation and participation of many people representing diverse disciplines and expertise. EIF and EIA were joined by the National Association of State Directors of Vocational Technical Education, the International Association of Machinists and Aerospace Workers, and a coalition of other industry, labor and education

Directors of Vocational Technical Education, the International Association of Machinists and Aerospace Workers, and a coalition of other industry, labor and education organizations in a collaborative effort to manage the project. More than 200 workers, supervisors, administrators, executives, and educators from approximately 100 participating companies, government agencies, institutions, unions, and associations worked side by side in meetings across the country to develop the workable, mutually agreeable standards contained in the working draft of the skill standards.

The working groups identified clusters of skills and competencies that technicians need in order to perform ably the duties and tasks required of each specialty occupation. The project staff compiled and compared the skill sets for each occupation to identify those common to all or most of the specialties. Those common skills formed the working draft of the skill standards.

This emerging standard is the only serious effort that was uncovered in the in-depth search for a telecommunications manufacturing production specialist. Although the standard is somewhat more general that the specific specialist sought, it should serve as an excellent starting point for the development of curricula to train and certify a telecommunications manufacturing production specialist.

**Electronics Technician Skills for Today and Tomorrow**

The skill standards under development by the Electronic Industries Association and the Electronic Industries Foundation identifies the standard skills required of a work-ready, entry-level electronics technician. It provides a valuable resource for students considering careers as electronics technicians; for counselors, educators, and academic administrators who prepare them for electronics careers; and for employers who depend on the vitality and capability of

a well-trained work force to supply the modern electronics demanded by American society. These standards should be extremely useful for colleges, schools, and training entities in Texas to create a system of technical and performance certificates and associate degrees for various levels of mastery.

The proficiency areas and the respective required skills are listed below:

**Proficiency Area: Desirable Behavior and Work Habits (P)**

**A. Work Ethics and Behavior**

A.01 Implement responsibilities of job position including exhibiting dependability and meeting organizationally defined expectations

A.02 Follow rules, regulations and policies as established including interpreting employer/employee handbook and procedures

A.03 Understand and practice cost effectiveness

A.04 Practice time management and follow work schedule

A.05 Assume responsibility for own decisions and actions

A.06 Exhibit pride

A.07 Display initiative in undertaking new tasks

A.08 Show assertiveness appropriate to the situation

A.09 Seek work challenges

A.10 Understand and apply ethical principles to decision making

A.11 Comply with company standards including dress, personal hygiene and cleanliness

A. 12 Understand the importance of providing good customer service (internal and external)

**B. Interpersonal Relationships**

B.01 Respond constructively to suggestions for improvement

B.02 Provide praise and suggestions for improvement

B.03 Channel/control emotional reactions constructively

B.04 Recognize problems and work toward their solution

B.05 Exhibit positive behavior

B.06 Exhibit sensitivity to internal and external customer needs

B.07 Treat people with respect

B.08 Recognize non-verbal communication

**C. Teamwork**

C.01 Understand interactive relationships required for effective teamwork

C.02 Understand team's operating procedures

C.03 Adapt as necessary to complete the team task

C.04 Evaluate outcome

**Proficiency Area: Technical Skills (T)**

**A. General Skills**

A.01 Demonstrate an understanding of proper safety techniques for all types of circuits and components (DC circuits, AC circuits, analog circuits, digital circuits, discrete solid-state circuits, microprocessors)

A.02 Demonstrate an understanding of and comply with relevant OSHA safety standards

A.03 Demonstrate an understanding of proper troubleshooting techniques

A.04 Demonstrate an understanding of basic assembly skills using hand and power tools

A.05 Demonstrate an understanding of acceptable soldering/desoldering techniques, including through-hole and surface mount devices

A.06 Demonstrate an understanding of proper solderless connections

A.07 Demonstrate an understanding of use of data books and cross reference/technical manuals to specify and requisition electronic components

A.08 Demonstrate an understanding of the interpretation and creation of electronic schematics, technical drawings, and flow diagrams

A.09 Demonstrate an understanding of design curves, tables, graphs, and recording of data

A.10 Demonstrate an understanding of color codes and other component descriptors

A.11 Demonstrate an understanding of site electrical and environmental survey

A.12 Demonstrate the use of listing skills or assertive devices to assess signs and symptoms of malfunctions

## B. DC Circuits

B.01 Demonstrate an understanding of sources of electricity in DC circuits

B.02 Demonstrate an understanding of principles and operation of batteries

B.03 Demonstrate an understanding of the meaning of and relationships among and between voltage, current, resistance and power in DC

B.04 Demonstrate an understanding of measurement of resistance of conductors and insulators and the computation of conductance

B.05 Demonstrate an understanding of application of Ohms Law to series, parallel and series-parallel circuits

B.06 Demonstrate an understanding of magnetic properties of circuits and devices

B.07 Demonstrate an understanding of the physical, electrical characteristics of capacitors and inductors

B.08 Understand principles and operations of DC series circuits

B.09 Fabricate and demonstrate DC series circuits

B.10 Troubleshoot and repair DC series circuits

B.11 Understand principles and operations of DC parallel circuits

B.12 Fabricate and demonstrate DC parallel circuits

B.13 Troubleshoot and repair DC parallel circuits

B.14 Understand the principles and operations of DC series-parallel and bridge circuits

B.15 Fabricate and demonstrate DC series-parallel and bridge circuits

B.16 Troubleshoot and repair DC series-parallel and bridge circuits

B.17 Understand the principles and operations of the Wheatstone Bridge

B.18 Understand principles and operations of DC voltage divider circuits (loaded and unloaded)

B.19 Fabricate and demonstrate DC voltage divider circuits (loaded and unloaded)

B.20 Troubleshoot and repair DC voltage divider circuits (loaded and unloaded)

B.21 Understand principles and operations of DC RC and RL circuits

B.22 Fabricate and demonstrate DC RC and RL circuits

B.23 Troubleshoot and repair DC RC and RL circuits

B.24 Demonstrate an understanding of measurement of power in DC circuits

## C. AC Circuits

C.01 Demonstrate an understanding of sources of electricity in AC circuits

C.02 Demonstrate an understanding of the properties of an AC signal

C.03 Demonstrate an understanding of the principles of operation and characteristics of sinusoidal and non-sinusoidal wave forms.

C.04 Demonstrate an understanding of basic motor/generator theory and operation

C.05 Demonstrate an understanding of measurement of power in AC circuits

C.06 Demonstrate an understanding of the principle and operation of various power conditioning: (isolation transformers, surge suppressors, uninterruptable power systems)

C.07 Demonstrate an understanding of the principle and operation of safety grounding systems: (lightning arresters, ground fault interrupters, etc.)

C.08 Understand principles and operations of AC capacitive circuits

C.09 Fabricate and demonstrate AC capacitive circuits

C.10 Troubleshoot and repair AC capacitive circuits

C.11 Understand principles and operations of AC inductive circuits

C.12 Fabricate and demonstrate AC inductive circuits

C.13 Troubleshoot and repair AC inductive circuits

C.14 Understand principles and operations of AC circuits using transformers

C.15 Demonstrate an understanding of impedence matching theory

C.16 Fabricate and demonstrate AC circuits using transformers

C.17 Troubleshoot and repair AC circuits using transformers

C.18 Understand principles and operations of AC differentiator and integrator circuits (determine RC and RL time constants)

C.19 Fabricate and demonstrate AC differentiator and integrator circuits

C.20 Troubleshoot and repair AC differentiator and integrator circuits

C.21 Understand principles and operations AC series and parallel resonant circuits

C.22 Fabricate and demonstrate AC series and parallel resonant circuits

C.23 Troubleshoot and repair AC series and parallel resonant circuits

C.24 Understand principles and operations of AC RC, RL, and RLC circuits

C25 Fabricate and demonstrate AC RC, RL, and RLC circuits

C.26 Troubleshoot and repair AC RC, RL, and RLC circuits

C.27 Understand principles and operations of AC frequency selective filter circuits

C.28 Fabricate and demonstrate AC frequency selective filter circuits

C.29 Troubleshoot and repair AC frequency selective filter circuits

C.30 Understand principles and operations of AC polyphase circuits

C.31 Understand principles and operations of AC phase locked loop circuits

C.32 Troubleshoot and repair AC phase locked loop circuits

**D. Discrete Solid State Devices**

D.01 Demonstrate an understanding of the properties of semiconductor materials

D.02 Demonstrate an understanding of PN junctions

D.03 Demonstrate an understanding of bipolar transistors

D.04 Demonstrate an understanding of field effect transistors (FET's/MOS-FET's)

D.05 Demonstrate an understanding of special diodes and transistors

D.06 Understand principles and operations of diode circuits

D.07 Fabricate and demonstrate diode circuits

D.08 Troubleshoot and repair diode circuits

D.09 Understand principles and operations of optoelectronic circuits (gate isolators, interrupt sensors, infra-red sensors, etc.)

D.10 Fabricate and demonstrate optoelectronic circuits (gate isolators, interrupt sensors, infra-red sensors, etc.)

D.11 Troubleshoot and repair optoelectronic circuits (gate isolators, interrupt sensors, infra-red sensors, etc.)

D.12 Understand principles and operations of single stage amplifiers

D.13 Fabricate and demonstrate single stage amplifiers

D.14 Troubleshoot and repair single stage amplifiers

D.15 Understand principles and operations of thyristor circuitry (SCR, TRIAC, DIAC, etc.)

D.16 Fabricate and demonstrate thyristor circuitry (SCR, TRIAC, DIAC, etc.)

D.17 Troubleshoot and repair thyristor circuitry (SCR, TRIAC, DIAC, etc.)

**E. Analog Circuits**

E.01 Understand principles and operations of multistage amplifiers

E.02 Fabricate and demonstrate multistage amplifiers

E.03 Troubleshoot and repair multistage amplifiers

E.04 Understand principles and operations of IF circuits

E.05 Fabricate and demonstrate IF circuits

E.06 Troubleshoot and repair IF circuits

E.07 Understand principles and operations of linear power supplies and filters

E.08 Fabricate and demonstrate linear power supplies and filters

E.09 Troubleshoot and repair linear power supplies and filters

E.10 Understand principles and operations of operational amplifier circuits

E.11 Fabricate and demonstrate operational amplifier circuits

E.12 Troubleshoot and repair operational amplifier circuits

E.13 Understand principles and operations of audio power amplifiers

E.14 Fabricate and demonstrate audio power amplifiers

E.15 Troubleshoot and repair audio power amplifiers

E.16 Understand principles and operations of regulated and switching power supply circuits

E.17 Troubleshoot and repair regulated and switching power supply circuits

E.18 Understand principles and operations of active filter circuits

E.19 Troubleshoot and repair active filter circuits

E.20 Understand principles and operations of sinusoidal and non-sinusoidal oscillator circuits

E.21 Troubleshoot and repair sinusoidal and non-sinusoidal oscillator circuits

E.22 Understand principles and operations of fiber optic circuits using photodiodes or LASERS

E.23 Troubleshoot and repair fiber optic circuits using photodiodes or LASERS

E.24 Understand principles and operations of RF circuits

E.25 Fabricate and demonstrate RF circuits

E.26 Troubleshoot and repair RF circuits

E.27 Understand principles and operations of signal modulation (AM, FM, stereo)

E.28 Troubleshoot and repair signal modulation (AM, FM, stereo)

E.29 Demonstrate an understanding of motor phase shift control circuits

E.30 Understand principles and operations of microwave circuits

## F. Digital Circuits

F.01 Demonstrate an understanding of the characteristics of integrated circuit (IC) logic families

F.02 Demonstrate an understanding of minimizing logic circuits using Boolean operations

F.03 Understand principles and operations of linear integrated circuits

F.04 Troubleshoot and repair linear integrated circuits

F.05 Understand principles and operations of types of logic gates

F.06 Fabricate and demonstrate types of logic gates

F.07 Troubleshoot and repair types of logic gates

F.08 Understand principles and operations of combinational logic circuits

F.09 Fabricate and demonstrate combinational logic circuits

F.10 Troubleshoot and repair combinational logic circuits

F.11 Understand principles and operations of types of flip-flop circuits

F.12 Fabricate and demonstrate types of flip-flop circuits

F.13 Troubleshoot and repair flip-flop circuits

F.14 Understand principles and operations of types of registers and counters

F.15 Fabricate and demonstrate types of registers and counters

F.16 Troubleshoot and repair types of registers and counters

F.17 Understand principles and operations of clock and timing circuits

F.18 Fabricate and demonstrate clock and timing circuits

F.19 Troubleshoot and repair clock and timing circuits

F.20 Understand principles and operations of types of arithmetic-logic circuits

F.21 Troubleshoot and repair types of arithmetic-logic circuits

F.22 Understand principles and operations of types of multiplexer and demultiplexer circuits

F.23 Troubleshoot and repair types of multiplexer and demultiplexer circuits

F.24 Understand principles and operations of types of digital to analog and analog to digital circuits

F.25 Troubleshoot and repair types of digital to analog and analog to digital circuits

F.26 Understand principles and operations of types of digital display circuits

F.27 Troubleshoot and repair types of digital display circuits

F.28 Understand principles and operations of power distribution noise problems

F.29 Troubleshoot and repair power distribution noise problems

F.30 Understand principles and operations of types of digital encoders and decoders

F.31 Troubleshoot and repair types of digital encoders and decoders

F.32 Understand principles and operations of digital display devices

F.33 Troubleshoot and repair digital display devices

## G. Microprocessors

G.01 Demonstrate an understanding of microprocessor interfaces

G.02 Troubleshoot and repair microprocessor interfaces

G.03 Demonstrate an understanding of essential microprocessor components

G.04 Demonstrate an understanding of microprocessor BUS concepts

G.05 Demonstrate an understanding of microprocessor components and terminology

G.06 Understand principles and operations of types of microprocessor memory circuits

G.07 Troubleshoot and repair types of microprocessor memory circuits

G.08 Understand principles and operations of microprocessor machine code and instruction sets

**H. Microcomputers**

H.01 Demonstrate an understanding of microcomputer operating systems

H.02 Demonstrate an understanding of essential microcomputer components

H.03 Demonstrate an understanding of microcomputer peripherals

H.04 Set up and configure a microcomputer using available operating systems and software packages

H.05 Troubleshoot and replace microcomputer peripherals

**Proficiency Area: Test Equipment and Tools (E)**

**Knowing and Understanding How the Test Equipment or Tool Works and When, Where, and How to Use It**

TE.01 Breakout box

TE.02 Calibration standards

TE.03 Capacitor/inductor analyzer

TE.04 Current probe

TE.05 DC power source

TE.07 Dummy load

TE.08 Electrical field strength meter

TE.09 Electrical resistance insulation tester

TE.10 Electrostatic discharge meter (ESD)

TE.11 Frequency counter

TE.12 Function generator

TE.13 Ground fault testers

TE.14 Hand tools

TE.15 High potential testers

TE.16 Isolation transformer

TE.17 LASER power meter

TE.18 Light intensity meter

TE.19 Logic analyzer

TE.20 Logic probe

TE.21 Logic pulser

TE.22 Multimeters (digital and analog)

TE.23 Oscilloscope

TE.24 Power tools

TE.25 Pressure gauges

TE.26 RF power meter

TE.27 RF signal generator

TE.28 Semiconductor tester

TE.29 Soldering/desoldering equipment and supplies

TE.30 Soldering/desoldering equipment and supplies for surface mount devices (SMD)

TE.31 Spectrum analyzer

TE.32 Temperature transducer

TE.33 Torque measuring tools

TE.34 Vacuum gauges

TE.35 Voltage Isolation Transformer (adjustable)

**Proficiency Area: Basic and Practical Skills (B)**

**A. Technical Literacy**

A.01 Demonstrate basic keyboarding skills

A.02 Demonstrate ability to use standard applications software such as word processors, database management, and spreadsheets

A.03 Maintain state-of-the-art skills through participation in in-service or other training

A.04 Participate in continuing education

A.05 Understand and apply continuous improvement principles (see Data Analysis)

A.06 Demonstrate knowledge of the business products/services

**B: Communication on the Job**

B.01 Use effective written and other communication skills

B.02 Use telephone etiquette including relaying messages accurately

B.03 Employ appropriate skills for gathering and retaining information

B.04 Interpret written, graphic and oral instructions

B.05 Interact with co-workers and customers in a logical, clear and understandable manner

B.06 Use language appropriate to the situation

B.07 Participate in meetings in a positive and constructive manner

B.08 Use job-related terminology

B.09 Write technical reports, letters and memoranda as appropriate to the audience (e.g., management, customers, co-workers, and manufacturers)

B.10 Document work projects, procedures, tests, and equipment failures

**C. Solving Problems and Critical Thinking**

C.01 Identify the problem

C.02 Clarify purposes and goals

C.03 Identify available solutions and their impact including evaluating credibility of information, and locating information

C.04 Evaluate options

C.05 Set priorities

C.06 Select/implement options/decisions including predicting results of proposed action

C.07 Organize personal workloads

## D. Reading

D.01 Read and apply varicus sources of technical information (e.g., manufacturer literature, codes and regulations)

## E. Proficiency in Mathematics

### General

E.01 Determine if a solution is reasonable

E.02 Demonstrate ability to use a simple electronic calculator

### Numbers and Number Relations

E.03 Round and/or truncate numbers to designated place value

E.04 Compare order and determine equivalencies of real numbers (e.g., fractions, decimals, percentages)

E.05 Solve problems and make applications involving integers, fractions, decimals, percentages, and ratios using order of operations

E.06 Translate written and/or verbal statements into mathematical expressions

E.07 Compare, compute, and solve problems involving binary, octal, decimal, and hexadecimal numbering systems.

### Measurement

E.08 Convert, compare, and compute with common units of measurement within and across measurement systems

E.09 Read scale on measurement device(s) and make interpolations where appropriate

**Data Analysis**

E.10 Understand statistical terms and charts needed for interpretation of continuous improvement processes

E.11 Collect and organize data into tables, charts, and/or graphs

E.12 Interpret and use tables, charts, maps, and/or graphs

E.13 Identify patterns, note trends, and/or draw conclusions from tables, charts, maps, and/or graphs

E.14 Compute and interpret mean, median, and/or mode

**Algebra**

E.15 Simplify and solve algebraic expressions and formulas

E.16 Select and use formulas appropriately

E.17 Understand and use scientific notation

E.18 Use properties of exponents and logarithms

E.19 Determine slope, midpoint and distance

E.20 Graph functions

E.21 Use Boolean algebra to break down logic circuits

**Geometry**

E.22 Determine perimeters and areas of geometric figures

E.23 Determine surface areas and volumes of applicable geometric figures

E.24 Recognize, classify, and use properties of lines and angles

E.25 Recognize, classify, and use properties of two- and three-dimensional figures(e.g., circles, triangles, rectangles, cylinders)

E.26 Apply Pythagorean theorem

**Trigonometry**

E.27 Identify basic functions of sine, cosine, and tangent

E.28 Compute and solve problems using basic trigonometric functions

E.29 Graph basic functions using polar and/or Cartesian coordinate systems

**F. Proficiency in Physics**

F.01 Understand fundamental principles of mechanics

F.02 Understand fundamental principles of pneumatics

F.03 Understand fundamental principles of hydraulics

F.04 Understand principles of electricity including its relationship to the nature of matter

**Proficiency Area: Additional Skills (A)**

**A. Communications**

A.01 Transmission line applications

A.02 Antenna Systems

A.03 Types of multiplexing systems

A.04 Data communications

A.05 Types of telephone switching systems

A.06 Microwave communications systems

## B. Electromechanics

B.01 Servomechanisms, motors, and motor control circuits
- a. Power distribution systems
- b. Relays and relay circuits
- c. Protection circuits
- d. Types of motor controllers
- e. Types of motors

B.02 Hydraulic and pneumatic systems

B.03 Mechanical power transmission systems
- a. Measuring instruments
- b. Compound and reverted gear trains
- c. Internal and planetary gear trains
- d. Helical and bevel gear trains
- e. Rack and pinion mechanisms
- f. Worm and wheel mechanisms
- g. Block and screw mechanisms
- h. Counter rotating mechanisms and differentials, etc.

B.04 Vacuum systems and components

B.05 Mechanisms, linkages and levers

B.06 Transducers and instrumentation

B.07 Industrial materials

B.08 Automatic controls and robotics

## C. LASER Applications

C.01 Welding, cutting and drilling

C.02 Data recording and manipulation

C.03 Environmental testing and monitoring

C.04 Nondestructive testing

C.05 Measurement

C.06 Communications

C.07 Fiber optics and lasers

C.08 Lasers in medicine

C.09 Holography/Interferometry

# SCANS Skills

In 1991 a cooperative effort between industry and government was started with the Secretary's Commission on Achieving Necessary Skills (SCANS) to identify workplace skills required of entry-level workers to keep America competitive in the world marketplace. The workplace skills identified by SCANS is made up of five workplace competencies and a three-part foundation of skills and personal qualities that are required for solid job performance. These are:

**Workplace Competencies**: Effective workers can productively use:

I RESOURCES: They know how to allocate time, money, materials, space and staff.

II INTERPERSONAL SKILLS: They can work on teams, teach others, serve customers, lead, negotiate, and work well with people from culturally diverse backgrounds.

III INFORMATION: They can acquire and evaluate data, organize, and maintain files, interpret and communicate, and use computers to process information.

IV SYSTEMS: They understand social, organizational, and technological systems; they can monitor and correct performance; and they can design or improve systems.

V TECHNOLOGY: They can select equipment and tools, apply technology to specific tasks, and maintain and trouble shoot equipment.

**FOUNDATION SKILLS:** Competent workers in the high-performance workplace need:

A BASIC SKILLS: reading, writing, arithmetic and mathematics, speaking, and listening.

B THINKING SKILLS: The ability to learn, to reason, to think creatively, to make decisions, and to solve problems.

C PERSONAL QUALITIES: individual responsibility, self-esteem and self-management, sociability, and integrity.

The Electronic Foundation skills and the AT&T DACUM information were arranged in matrix form in contrast with the SCANS skills. The matrix was developed by placing each EIF skill in only one SCAN skill category. In order to better identify all SCAN skills addressed by a single EIF skill, a panel of experts involved in the development of the EIF standard would need to carefully analyze each skill. By doing so, a given EIF skill could then be noted as addressing several SCAN skills. A comparison of the resulting information is not particularly informative without a panel of experts interpreting all of the areas satisfied by each skill set forth. The DACUM skills were developed with the SCANS skills specifically in mind; however, they are lacking the specificity of the EIF skills in regard to the clarity of the precise skill.

Charlie Blanton and Don Williams met on May 23-24, 1995 with an EIF team to review the relevancy of their current material for measuring the skills for their standard. The minutes of that meeting are included as Appendix B. The focus of the meeting was to discuss the EIF Measurements and Results Criteria for the EIF skills standards. The EIF Measurements and Results Criteria are included as Appendix C.

| SCANS Skills | Electronics Industries Foundation Skills | AT&T DACUM |
|---|---|---|
| **WORKPLACE COMPETENCIES** | | |
| I RESOURCES: They know how to allocate: | | |
| time | PA4 | WA1, T4 |
| money | PA3 | WA2, T4,9 |
| materials | | WA3, E1-32, T2-5 |
| space | | WA4, T4 |
| staff | | WA5, T4 |
| II INTERPERSONAL SKILLS: They can: | | |
| work on teams | PC1,2,3 | WB1, FC11 |
| teach others | | WB2 |
| serve customers | PA12, PB6 | WB3 |
| lead | PA7,8,9, PB2 | WB4 |
| negotiate | BB5 | WB5 |
| work well with people from culturally diverse backgrounds | BB5,7 | WB6 |
| III INFORMATION: They can | | |
| acquire and evaluate data | PC4, BB3,10 | WC1, T1-9 |
| interpret and communicate | TA7-11, BE10,12-14 | WC3 |
| use computers to process information | TH1-4, BA1,2 | WC4 |

| | | |
|---|---|---|
| IV SYSTEMS:<br>They: | | |
| understand social, organizational, and technological systems | TA2,TB1-8 | WD1 |
| can monitor and correct performance | TC1 | WD2 |
| can design or improve systems | TB9,12,15,19,22,<br>TC2-4,6-9,11,14-16,18,19,21,22,24, 25,27,28,30,31,<br>TD1-7,9,10,12,13,15,16,<br>TE1,2,4,5,7,8,10,11,13,14,16,18,20, 22,24,25,27,29,30,<br>TF1-3,5,6,8,9,11,12,14,15,17,18,20, 22,24,26,28,30,32<br>TG1,3-6,8 | WD3, T6 |
| V TECHNOLOGY:<br>They can: | | |
| select equipment and tools | TA1,4-6, TB11,14,17,18,21,24, TC5<br>E1-35 | WE1, T1-9 |
| maintain and trouble shoot equipment | TA3,12, TB10,13,16,20,23,<br>TC10,13,17,20,23,26,29,32,<br>TD11,14,17,<br>TE3,6,9,12,15,17,19,21,23,26,28<br>TF4,7,10,13,16,19,21,23,25,27,29, 31,33<br>TG2,7, TH5<br>AA1-6, AB1-8, 1C1-9 | WE3 |

| FOUNDATIONS SKILLS:<br><br>A BASIC SKILLS: | | |
|---|---|---|
| reading | PD1,BB4,BE9 | FA1 |
| writing | BB1,9 | FA2 |
| arithmetic and mathematics | BE7,8,15-29, BF27-29 BG1-4 | FA3 |
| speaking | BB1,8 | FA4 |
| listening | BB5 | FA5 |
| learn | | FB1 |
| reason | BC2-4 | FB2 |
| think creatively | BA5, BC1 | FB3 |
| make decisions | BC5 | FB4 |
| solve problems | PB4, BC6 | FB5 |
| C PERSONAL QUALITIES: | | |
| individual responsibility | PA1,2,5 BA3,4,6 | FB4, WE2<br>FC2,3,5,6,7 |
| self-esteem and self-management | PA6, PB1, BC7 | FC1 |
| sociability | PA11, PB3,5,7 | FC8,9 |
| integrity | PA10 | FC7 |

Abbreviations: EIF Skills

P: Desirable Behavior and Work Habits
T: Technical Skills
E: Test Equipment and Tools
B: Basic and Practical Skills
A: Additional Skills

AT&T DACUM

F: Foundation Skills
W: Workplace Competencies
T: Technical Knowledge
E: Equipment/Tools

**Conclusion**

In his work, *The Wealth Of Nations* (1776), Adam Smith described the intellectual, social, and economic conditions of the period, a period in which one nation's wealth competed against the wealth of other nations. By 1995 the economy had made a dramatic shift from a national economy to a global economy, the impact of which is still not understood by many of those in the education and training fields.

The United States, like most countries, no longer measures wealth by the Gross National Product (GNP); rather, wealth is now measured by Gross Domestic Product (GDP). GNP attempts to measure the wealth of companies chartered in the United States to include profits generated under that company charter in other countries. GDP measures profits generated inside a nation's geographical boundaries with no regard for national ownership.

While there are many publications that document this economic shift, one of the more prominent works is by the economist Robert Reich. In his book *The Work Of Nations* (1991), Reich notes that by the last decade of the twentieth century the national economy had dramatically changed into a global economy. "The competitiveness of Americans in this global market is coming to depend, not on the fortunes of any American corporation or on American industry, but on the functions that Americans perform – the value they add – within the global economy. In a very few years, there will be virtually no way to distinguish one national economy from another except by the exchange rates of their currencies – and even this distinction may be on the wane."

The emerging research about the future work areas indicates three major divisions emerging in the United States as well as other countries. They are (1) routine production services, (2) in-person services, and (3) symbolic-analytic services. The three divisions cover more than 75% of the jobs available in the United States today. The definitions of the three services are as follows:

1. Routine production services: perform repetitive tasks -- one step in a sequence of steps for producing finished products tradable in world commerce.
2. In-person services: services provided person-to-person, often entails simple and repetitive tasks that are not marketed worldwide.
3. Symbolic-analytic services: includes all problem solving, problem identifying, and strategic-brokering activities.

The telecommunications manufacturing production specialist seemingly falls into the category of routine production services. These producers typically work in the company of many other people who do the same thing, often within large enclosed spaces. They are guided on their jobs by standard procedures and codified rules, and even their overseers are overseen, in turn by people who monitor -- often with the aid of computers. These production specialists comprise about twenty-five percent of jobs performed by Americans. However, those production specialists who possess the EIF skills and the SCANS skills will be able to perform some limited symbolic-analytic services in their jobs.

From the in-depth research conducted in conjunction with this project, It appears that there does not exist any current, known national, or international, skill standards for the telecommunications manufacturing production specialist. The nearest related guidelines would be those for an "electronics technician" that are being developed by the Electronics Industries Foundation.

**Recommendations**

As noted earlier in this report, educational standards are critical to America's global competitiveness. Eastfield College believes that they have an obligation to know and apply the latest standards and practices of industry when preparing students for employment. In reality that is the objective of the instructional scope of all community colleges, to know and apply the latest standards and practices of the educational community in the preparation of students. Students should exit the instructional process competent to perform in appropriate settings. That is the driving force behind the SCANS workplace know-how and recommendations for the "Learning A Living" System.

Motivation of personnel begins with their understanding of the tasks they are expected to perform and how those tasks support the overall activities. Educators should be made aware of the advantageous effects of proper job performance at all levels, and of the effects of poor job performance on other educators, student learning, student/employer satisfaction, and the well-being of the institution, the image of the institution, and the companies they serve.

To create a culture of quality, creativity, trust, empowerment, and standards-centered leadership, an inside-out approach is necessary at four levels: personal,

interpersonal, managerial, and organizational. These four levels must focus on the essentials of quality to transform education. The American Society for Quality Control (ASQC) and the American National Standards Institute (ANSI) have advanced a national standard for the Design of Instruction Within a Quality System. The current draft standard is the Quality Management and Quality Assurance Standards - Guidelines for the Application of ANSI/ASQC Q9001-1994 or Q9002-1994 to Education and Training Institutions. It is also referred to as Z-1.11. If the community college system desires to expand the belief and findings documented in this report they would do well to investigate the Z-1.11 project.

Z-1.11 is a project of the joint efforts of the ANSI and the ASQC Accredited Standards Committee Z-1 on Quality Assurance. Community colleges implementing the skill-standards work of the "Partnership to Pave the International Information Highway" might well use this work as a baseline to expand skill standards to the entire community college system. Consideration should be given to using the Plan-Do-Study-Act cycle to implement the Z-1.11 Analyzing the design of instruction within a quality system at each campus in the state community college system may well be the decisive act that gives an organization the ability to learn. Peter Senge, author of *The Fifth Discipline*, notes "An organization's ability to learn may make the difference between its thriving or perishing in the years ahead."

The community college system is the most viable link the community has in the retraining of the workforce needed to keep pace with the ever-changing business and technology demands. Certainly the major concern of administration of these systems is to continue to thrive in a systematic and cost-effective approach to excellence in

community colleges. Modeling Z-1.11 leadership would demonstrate that workplace know-how called for in the area of systems:..."they can monitor and correct performance; and they can design or improve systems." A copy of the Z-1.11 document is attached as Appendix D for review and consideration.

Any Texas community college wishing to effectively provide a quality curriculum for a telecommunications manufacturing production specialist or electronics technician would benefit greatly from the following six recommendations:

1. Compare the work of the DACUM to the curriculum currently in place at their community college and note major areas of difference or deficiency. Work continuously to bring the former curriculum in line with the desired DACUM.
2. Use every opportunity to instill workplace know-how (the SCANS foundations and workplace competencies) and critical thinking skills into the entire continuum of community college education. Critical thinking is defined as clarity of thought, accuracy of thought, and fairness of thought.
3. In realigning curriculum, in order to prevent duplication of effort and thus creating waste, consider the work done by the Texas Education Articulation Model (TEAM) Consortium and the Emerging Skills Standards for the Electronics Industries Association. Both of these groups have done extensive work that will be profitable to the community colleges in Texas. Also consideration should be given to cooperating with the Statistics Division of the American Society for Quality Control (ASQC). The Statistics Division of ASQC has formed a subcommittee to work on "integrating statistical thinking into all educational curricula." "Statistical thinking,"

as used by the Statistics Division, refers to those thought processes that recognize that:

- All work occurs in a system of interconnected processes, each of which has customers.
- Variation exists in all processes.
- Causes of variation can be loosely segregated into "common" and "special" causes.
- Understanding the unique nature of both common and special causes is the key to reducing variation.
- Reducing variation is the key to improving quality, productivity, and profitability.

The Statistics Division is currently looking for educational organizations to work with members of their subcommittee to assist organizations in transforming from their current method of operation into one of continuous improvement throughout the entire organization. They are attempting to build case studies in education where such transformations have occurred and have been successful.

4. In interviews with the educational delivery providers, the lack of knowledge about the important aspects of quality is startling. Even the DACUM notes safety and quality at the end of the process rather than at the front end and of utmost importance to the process. Certainly the vocational and technical programs are a key place to start this type of "quality" thinking.
5. Apply process improvement concepts and tools to master the processes involved in working through the desired curriculum changes and/or additions with respect to

quality at the end of the process rather than at the front end and of utmost importance to the process. Certainly the vocational and technical programs are a key place to start this type of "quality" thinking.

5. Apply process improvement concepts and tools to master the processes involved in working through the desired curriculum changes and/or additions with respect to only the telecommunications manufacturing productions specialist using the Plan - Do - Study - Act cycle. Then use the same approach to obtain the same desired transformation to other academic areas in the community college curriculum.
6. Implement a better selection process for students wishing to participate in the "telecommunications manufacturing production specialist" or "electronics technician" program. Currently, the comparison of the DACUM skills shows that skill FC12 (Electro-Mechanical Aptitude - see section 3, page 6, Figure 2) does not align with the SCANS skills. Since aptitude means "natural disposition or tendency," it is possible for a student to enter the program without this aptitude and could, consequently, not be able to perform at the desired level of competency. In short, the student's selection to enter the program is self selection. A level of screening should be developed that would assure that all students entering the program would possess a minimum level of electro-mechanical aptitude.

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# PARTNERS

## IN PROFOUND KNOWLEDGE

### CAPABILITIES STATEMENT

Partners in Profound Knowledge help organizations blend systematic mandates and programs with synergistic educational innovation requiring continued focus on learning and adapting. The partners bring 90 years plus of combined experience in tools and proven methods to improve educational performance, improve process creativity skills, improve operational efficiencies, and develop performance measures.

Charlie Blanton, Ed.D., has spent 34 years in the educational arenas of teaching and administration. He has directed strategic planning, implementation, and evaluation of a variety of activities and services among academic, governmental, and corporate entities. He is a member of the Educational and Training Sector to work along with industry sectors under the American National Standards Institute and teaches educational administration at Texas Woman's University.

F. LeRoy Walser, Ed.D., is director of the Center on Standards for Quality at the University of Oklahoma. He has developed strategies for preparing people to use the Quality Sciences and voluntary standards in the service and industry of the economy. The Center has produced national and international conferences for educators, business, and public service employees. Dr. Walser is a member of the Board of Directors of the American National Standards Institute.

Donald R. Williams, Ph.D., is the founder and former director of the Center for Quality and Productivity at the University of North Texas. Dr. Williams is experienced in the areas of statistical quality control, applied statistics, total quality management, quality management systems, process improvement, team facilitation, design of experiments, and problem solving. He has also served on the faculty at the University of Texas at Arlington, Oklahoma State University and the University of North Texas.

The partners have served on numerous educational and economic development committees and presently are working with the American National Standards Institute - Standards Council of Canada - CANACINTRA international forum for harmonizing standards, a private sector initiated effort associated with NAFTA .

Taxpayer Identification Number: 75-2492900



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PARTNERS

IN PROFOUND KNOWLEDGE

November 15, 1994

Ms. Celeste Guerrero
Interim Dean
Technology and Occupational Programs
Eastfield College
3737 Motley Drive
Mesquite, Texas 75150-2099

Dear Ms. Guerrero:

According to our conversation on Thursday, November 10, 1994, this is an acknowledgment of our revised understanding as to the role of Partners in Profound Knowledge (PPK) in the development of a telecommunications technician program for the DCCCD and Eastfield College. It is our understanding that PPK will assist Eastfield College in the development of a curriculum framework that defines basic skill standard concepts and technical skill standards for the telecommunications technician program.

In the attainment of the project goal, PPK will do the following tasks, as stated in the Texas Higher Education Coordinating Board Grant Application that was submitted by Eastfield College:

| | | |
|---|---|---|
| Objective A: | Activity 1: | Tasks a and d |
| | Activity 2: | Tasks b and c |
| | Activity 3: | Tasks a, b, and c |
| | Activity 4: | Tasks a and b |
| | Activity 5: | All |
| | Activity 6: | All |
| Objective B: | Activity 1: | All |
| | Activity 2: | Tasks b, c, and h |
| | Activity 3: | Assist |
| Objective C: | Activity 3: | All |

Attached is a breakdown of the tasks that PPK will perform and the estimated cost of each task. If you have any questions concerning these tasks or estimates, please give me a call.



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*Phone (214) 503-7735 Fax (214) 503-7736*

The work is to begin immediately upon signing of a contract. The reports are all due on or before June 15, 1995, and a final summary report is due on or before July 1, 1995.

Please give me a call when you have the contract ready for my signature. We look forward to working with you.

Sincerely,

Charlie Blanton, Ed.D

CB:drw
Attachment

# Proposal from Partners in Profound Knowledge to Assist Eastfield College

Partners in Profound Knowledge (PPK) proposes to assist Eastfield College in fulfilling the grant requirements from the Texas Higher Education Coordinating Board. The goal of the project is to establish a partnership to define standards of quality in both basic skill concepts and technical skills to ensure that telecommunication technology programs will be competitive in the international market place. Specifically, PPK is to be instrumental in developing a framework for updating existing curricula or developing new curriculum for a telecommunications technician program that is competitive for NAFTA and the USA, Canada and Mexico international market place.

The following represent a description of the tasks that PPK will perform:

| | | | |
|---|---|---|---|
| Objective A | Activity 1 | | |
| | | Task a | Contract with American National Standards Institute (ANSI) to locate existing regulations and standards. |
| | | Task d | Document specifically what new technical skills will be required of the technician in the international market place |
| | Activity 2 | | |
| | | Task b | Compare Mexico's technical skill standards to USA technical skill standards |
| | | Task c | Document similarities and differences in skill standards |
| | Activity 3 | | |
| | | Task a | Prepare a matrix to plot the technical skill standards of both countries |

| | |
|---|---|
| Task b | Compare the current telecommunications program competencies with the technical skills matrix in Task a above |
| Task c | Document technical skills currentiy taught that match those plotted on the matrix |
| Activity 4 | |
| Task a | Prepare a matrix to plot the technical skill standards of the three countries |
| Task b | Compare the current telecommunications program competencies with the technical skills matrix in Task a above |
| Activity 5 | Prepare a report outlining recommendations to incorporate the new necessary technical skills into the existing curriculum |
| Activity 6 | Prepare a summary report detailing:<br><br>- the results of all the studies<br>-what skills will be required of programs in order to be competitive in the international market place<br>-how to implement changes to ensure internationally competitive programs |

| | | |
|---|---|---|
| Objective B | Activity 1 | Survey work materials and measures for SCANS performance levels |
| | Activity 2 | |
| | Task b | Determine basic skills and level of SCANS skills required for current Mexican employees |
| | Task c | Determine basic skills and level of SCANS skills required for current Canadian employees |
| | Task h | Review ANSI report from consultant |
| | Activity 3 | Prepare report to the advisory committee indicating the results of the skills analysis study |
| Objective C | Activity 3 | Final report to advisory committee to include:<br><br>- plan for enhancing partnerships<br>- step-by-step outline for establishing industry-based skill standards and certification procedures<br>- framework for telecommunication technician curricula with industry standards for USA, Mexico, and Canada |

# MINUTES
## ELECTRONIC INDUSTRIES FOUNDATION/UNIVERSITY OF NORTH TEXAS
## DALLAS, TEXAS
## MAY 23 AND 24, 1995

On May 23, 1995, the meeting was called to order by Timothy D. Farr, Director of Research and Technology Applications from the Electronic Industries Foundation at 9:30 a.m. Those attending the two-day meeting included the following:

Charles McCameron
TEAM Electronics
Bee County College, ELES
3800 Charco Road
Beeville, TX 78102

Arnie Garcia
TEAM Electronics
TSTC - Harlingen
2424 Boxwood
Harlingen, TX 78550-3697

Wayne Freeland
Texas Instruments
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Don R. Williams
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Jessie Teddlie
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Bill E. Lovelace
University of North Texas
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Denton, TX 76203

Robert Gates
TEAM Electronics
Cisco Junior College
841 N. Judge Ely Blvd.
Abilene, TX 79601

Don Hatton
Staff Vice President
Electronic Industries
Association
2500 Wilson Boulevard
Arlington, VG 22201-3834

Timothy Farr explained the purpose of the meeting was to review materials currently developed with VTECS to provide proficiency levels for the entry level technician. The attached pages were reviewed, edited, and revised in order to become the second document of the EIF Project.

Don Hatton explained that the Electronic Industries Association will continue to lead in the completion of the documents needed for the industries and educational institutions for the training and hiring of entry level technician which could include a student profile approved nationwide, the development of an accepted assessment developed by a task force which included any and all associations, groups, institutions which currently provide any form of such assessments. The plan is to have the assessment task force agree, develop, and use one specific assessment for entry level electronic technicians. (see attached)

As a secondary part of this meeting, the project staff from the University of North Texas for the Skill Standards and Certification Project for Electronic Technicians funded by the Tri-Agency wanted to update the members on the current project and to obtain recommendations from the TEAM Consortium representatives as to possible needs and activities for a one year continuation of that project. It was noted that the enhanced curriculum, as enhanced at this time, would be copied and distributed to all the funding source as required, to all TEAM members, to Wayne Freeland and the representatives of the National Project at the end of the June funding period.

The TEAM representatives and the representatives from the National Projects, and Wayne Freeland from Texas Instruments provided recommendations.

It was recommended by the project staff and the representatives of the TEAM Consortium present that as part of the possible continuation of the Texas Skill Standard and Certification Project conducted by the University of North Texas/ Texas Instruments and funded by the Tri-Agency, that the following be included:

A. To continue to participate as regional focus group participants with the EIA National Project in the development of a nationally accepted student profile and assessment tool.

B. To continue to provide technical assistance to the TEAM curriculum consortium to incorporate the national products/information into the curriculum until completion and to document results of pilot testing semester in Fall 1995.

C. To provide training to postsecondary instructors from the consortium as to how to use the enhanced TEAM curriculum, to identify prerequisites needed, to sequence curricula, and to validate integration of academic and technical curricula which would include the application of or teaching of SCANS skills .

D. To provide training and technical assistance to Tech Prep Electronic instructors from the postsecondary and secondary levels to assure that the Tech Prep curricula will be revised to provide for a vertical curriculum based on workplace requirements. A finalized vertical curriculum can then be used to revise all secondary program curricula.

E. To offer training to secondary instructors on the development and use of the vertical curriculum for electronic training programs upon its completion.

F. To make on-site visits to postsecondary institutions offering entry level electronic training programs which

are not using the TEAM curriculum to encourage the use of the curriculum statewide and to offer training as how to use/teach from the TEAM curriculum to ensure a horizontal, statewide curriculum is being utilized by all institutions providing these training programs.

G. To coordinate and collaborate with the funded RFP 1400 (Curriculum Management), RFP 1100 (professional development), and RFP 1900 (Skill Standards) projects' staffs to ensure utilization of the research and products (including the statewide training manual) developed through the Skill Standards and Certification Project.

H. To coordinate and collaborate with other Skill Standard and Certification projects' staffs as determined and agreed upon.

I. To provide leadership and training to electronic program instructors using the TEAM curriculum on use and inclusion of second document provided by National Project involving performance measures and/or proficiency levels.

J. Provide a statewide staff development conference and/or workshops for electronic instructors (which could be provided annually) for both secondary and postsecondary instructors to provide additional industry training and/or awareness of the industry's changes in technologies and requirements. This could be done for two years with the agendas developed and approved by the Electronic Industries Foundation and the Electronic Industry Association and their industry members as well as from a survey of staff development needs of instructors, then assessed, and a determination made at that time if it is a valid method for meeting the needs of the instructors for program area training and updating.

(NOTE: It has been recommended by the National Projects' advisors and by the TEAM Consortium representatives that training (staff development) workshops/conference be provided as a part of the next year of this project for both secondary and postsecondary instructors. The training would fulfill the "training" requirements for service authorization for most major manufactures with the Electronic Industries Association being the trainers on the any following topics (the training period has been established by the Electronic Industries Association):

- Interfacing Microprocessors in PCs and PC Servicing (5 days required) (1st choice)
- VCR Technology and Servicing (5 days required)
- Video Laser Disc Technology and Servicing (3 days required)
- Color TV Technology and Servicing (3 days required)

- PC Servicing (3 days required)

While the Electronic Industries Association provides periodic training programs within the state, the focus of those programs, wheather for instructors or technicians, is for one-day of updating or awareness training. The TEAM Consortium has recommended that the detailed training be provided as well to meet current and future needs. There is no charge by the Electronic Industries Association for providing such training, but the site, equipment, materials, and other such preparation and planning for the training must be completed by the local staff hosting the training. This could be done in coordination with other needed and, as stated above, training, and this project staff could provide the marketing/organizing/etc. of the workshops and/or conference. The additional training needs of the secondary and postsecondary instructors could be identified and included each year and be scheduled at the time identified as most appropriate by the instructors to assure maximum participation. Career and Technology (vocational) funds could be utilized for travel expenses for instructors for such workshops/conferences and CEUs and possible college credits could be offered as incentives. Again, this would be training approved and recommended by the industry's leaders as needed by instructors to assure that training programs continued to meet the needs and requirements of the workplace.)

Occupation: General Electronics Technician

Proficiency Area: Desirable Behavior and Work Habits

A. Work Ethics and Behavior

B. Interpersonal Relationships

C. Teamwork

Please Note! This document is the most current version, including manual corrections, of the EIF Measurements and Results Criteria. The minutes of the meeting at which the corrections were made are included as Appendix B.

Occupation: General Electronics Technician

Proficiency Area: Desirable Behavior and Work Habits

**A. Work Ethics and Behavior**

Skill: A.01 Implement responsibilities of job position including exhibiting dependability and meeting organizationally defined expectations

MEASUREMENT CRITERIA

1. Interpreted job expectation from job manual and job description.
2. Listed the chain of command for dealing with problems.
3. Reported for work on time and prepared and was ready to start work.
4. Defined dependability as related to the job description.

RESULTS:

Demonstrated knowledge of the job position, responsibilities and the ability to implement responsibilities of the job position including exhibiting dependability and meeting organizationally defined expectations by the completion of each activity. The activities were completed in a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Desirable Behavior and Work Habits

**A. Work Ethics and Behavior**

Skill: A.02 Follow rules, regulations and policies as established including interpreting employer/employee handbook and procedures

MEASUREMENT CRITERIA

1. Listed methods/procedures for identifying company rules, regulations and policies.

2. Interpreted and explained the rules, regulations, and policies in an understandable way.

3. Identified reasons why following established company rules, regulations and policies are essential to a safe and efficient work environment.

4. Reviewed examples of employee performance evaluations and discussed how established rules, regulations and policies effect evaluation ratings.

RESULTS:

Demonstrated knowledge of employer rules, regulations and policies and the ability to follow the rules, regulations and policies as established by the employee handbook. The activities were completed in a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Desirable Behavior and Work Habits

**A. Work Ethics and Behavior**

Skill: A.03 Understand and practice cost effectiveness

MEASUREMENT CRITERIA

1. Defined cost effectiveness.

2. Identified the different types of costs incurred by an electronics business.

3. Listed ways that the electronics technician should practice cost effectiveness on the job.

4. Explained ways cost effectiveness practices help the employer/~~and~~ employee. and/or customer.

RESULTS:

Demonstrated knowledge of cost effectiveness practices and the ability to identify and implement cost effectiveness practices associated with an electronics technician's job by the completion of each activity. The activities were completed in a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Desirable Behavior and Work Habits

**A. Work Ethics and Behavior**

Skill: A.04 Practice time management and follow work schedule

MEASUREMENT CRITERIA

1. Explained the importance of time management to the employee and employer.

2. Listed techniques that allow a task to be completed in an efficient manner.

3. Reviewed time management situations electronics technicians encounter on the job and how the situations were handled.

4. Completed a time log and analyzed it to determine the effectiveness of time spent on each task.

RESULTS:

Demonstrated knowledge of time management practices and the ability to maintain established work schedule and initiate time management practices by the completion of each activity. The activities were completed in a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Desirable Behavior and Work Habits

**A. Work Ethics and Behavior**

Skill: A.05 Assume responsibility for own decisions and actions

MEASUREMENT CRITERIA

1. Explained the effects ~~(both~~ positive and negative~~)~~ that an action/decision ~~the electronics technician makes~~ has on the employer, employee or other individuals.

2. Emphasized the importance of the electronics technician accepting responsibility for any action or decision they make.

3. Evaluated a task to determine who should assume the decision making role and identified the action to take.

RESULTS:

Demonstrated knowledge of accepting responsibility and the ability to make decisions related to an electronics technician's job position and assumed responsibility for the actions taken or decisions made. The activities were completed in a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Desirable Behavior and Work Habits

**A. Work Ethics and Behavior**

Skill: A.06 Exhibit pride

MEASUREMENT CRITERIA

1. Defined pride.

~~2. Identified different types of work pride exhibited by employees and how they benefit the employer.~~

2 ~~3~~. Listed ways to exhibit pride.

3 ~~4~~. Explained how pride in the completion of a task reflects ~~positively or negatively~~ on the company.

4 ~~5~~. Interpreted consequences of lack of pride.

RESULTS:

Demonstrated knowledge of work pride and displayed pride in the work by the completion of each activity. ~~The activities were completed within a reasonable time frame.~~

Occupation: General Electronics Technician

Proficiency Area: Desirable Behavior and Work Habits

**A. Work Ethics and Behavior**

Skill: A.07 Display initiative in undertaking new tasks

MEASUREMENT CRITERIA

1. Explained work situations that provide employees an opportunity to display initiative.

2. Listed ways initiative can be displayed in the completion of a task.

3. Observed others completing a task and listed ways they displayed initiative.

4. Explained the consequences of lack of initiative.

RESULTS:

Demonstrated knowledge of workplace initiative and the ability to display initiative in undertaking new tasks by the completion of each activity. ~~The activities were completed in a reasonable time frame.~~

Occupation: General Electronics Technician

Proficiency Area: Desirable Behavior and Work Habits

**A. Work Ethics and Behavior**

Skill: A.08 Show assertiveness appropriate to the situation

MEASUREMENT CRITERIA

1. Explained assertiveness techniques.
2. Interpreted how actions can display both positive and negative assertiveness.
3. Listed situations requiring assertiveness in the work place.
4. Demonstrated assertiveness in the completion of a task.

RESULTS:

Demonstrated knowledge of workplace assertiveness and the ability to utilize proper assertiveness techniques for appropriate situations by the completion of each activity. ~~The activities were completed in a reasonable time frame.~~

Occupation: General Electronics Technician

Proficiency Area: Desirable Behavior and Work Habits

**A. Work Ethics and Behavior**

Skill: A.09 Seek work challenges

MEASUREMENT CRITERIA

1. Defined work challenge.

2. Identified work challenges in the electronics technician work area.

~~3. Described the advantages and disadvantages of seeking work challenges.~~

RESULTS:

Demonstrated knowledge of work challenges and the ability to identify and successfully seek work challenges in the electronics technician work field. ~~The activities were completed in a reasonable time frame~~.

Occupation: General Electronics Technician

Proficiency Area: Desirable Behavior and Work Habits

**A. Work Ethics and Behavior**

Skill: A.10 Understand and apply ethical principles to decision making

MEASUREMENT CRITERIA

1. Described ethical reasoning principles and their application to decision making.

2. ~~Explained the levels on which ethical reasoning may be applied in a work situation, employer/employee, employee/employee, and employee/customer.~~

2 3. Described a work situation that required ethical reasoning.

3 4. Applied ethical reasoning to the completion of a task.

RESULTS:

Demonstrated knowledge of ethical reasoning principles nd the ability to apply ethical principles to work related decisions by the completion of each activity. ~~The activities were completed in a reasonable time frame.~~

Occupation: General Electronics Technician

Proficiency Area: Desirable Behavior and Work Habits

**A. Work Ethics and Behavior**

Skill: A.11 Comply with company standards including dress, personal hygiene and cleanliness

MEASUREMENT CRITERIA

1. Identified the dress, hygiene and cleanliness standard outlined in the company manual.

2. Explained the consequences of not complying with company policies.

3. Interpreted the dress, personal hygiene and cleanliness standards as they relate to safety and company image.

4. Described methods for complying with company standards while maintaining personal rights.

5. Planned a wardrobe appropriate for the job performed.

RESULTS:

Demonstrated knowledge of established company standards and the ability to identify, interpret and comply with company standards by the completion of each activity. ~~The activities were completed in a reasonable time frame.~~

Occupation: General Electronics Technician

Proficiency Area: Desirable Behavior and Work Habits

**A. Work Ethics and Behavior**

Skill: A.12 Understand the importance of providing good customer service (internal and external)

MEASUREMENT CRITERIA

1. Identified the difference between internal and external customer service.

2. Explained the importance of business image in providing products/or services.

3. Listed ways to provide customers with positive service.

4. Read and interpreted company policy in dealing with customers.

5. Described ethical, social and legal responsibilities of ~~employee and employer to customers and employees.~~ providing good customer service -

RESULTS:

Demonstrated knowledge of customer service practices and the ability to provide good external and internal customer service and establish good customer relations by the completion of each activity.

Occupation: General Electronics Technician

Proficiency Area: Desirable Behavior and Work Habits

**B. Interpersonal Relationships**

Skill: B.01 Respond constructively to suggestions for improvement

MEASUREMENT CRITERIA

1. Explained the difference between constructive criticism and destructive criticism.

2. Explained the reasons for constructive suggestions for improvement.

3. Identified the benefits of responding constructively to suggestions for improvement.

4. Analyzed a situation and responded to suggestions for improvement.

5. Demonstrated willingness to improve by following suggestions for improvement.

RESULTS:

Demonstrated knowledge of the benefits of constructive criticism and the ability to respond to suggestions for improvement in a positive, constructive manner. ~~The activities were completed in a reasonable time frame~~.

Occupation: General Electronics Technician

Proficiency Area: Desirable Behavior and Work Habits

B. **Interpersonal Relationships**

Skill: B.02 Provide praise and suggestions for improvement

MEASUREMENT CRITERIA

1. Explained the need for praise and suggestions for improvement in the workplace.
2. ~~Emphasized~~ Explained the difference between positive and negative ~~praise/~~suggestions.
3. Listed appropriate times to offer praise and suggestions.
4. Identified methods for providing suggestions in a constructive manner.
5. Explained how voice/tone control and body language are important when providing praise and suggestions for improvement.

RESULTS:

Demonstrated knowledge of methods for providing praise and suggestions for improvement and the ability to provide praise and suggestions in a constructive manner. ~~The activities were completed in a reasonable time frame.~~

Occupation: General Electronics Technician

Proficiency Area: Desirable Behavior and Work Habits

**B. Interpersonal Relationships**

Skill: B.03 Channel/control emotional reactions constructively

MEASUREMENT CRITERIA

1. Described ~~how~~ the effects of emotional reactions to work situations. ~~are constructive or destructive depending on how the electronics technician channels or controls their emotions~~.

2. Explained the ~~importance of controlling emotional reactions, in order to~~ maintain good interpersonal and ~~professional relationships~~.

3. ~~Listed methods for channeling/controlling emotional reactions constructively.~~

4. Demonstrated emotional control in the completion of tasks.

5. Identified work situations in which electronic technicians would need to channel or control emotions.

6. Analyzed work situations to determine the best method for the electronics technician to constructively channel or control their emotional reactions.

RESULTS:

Demonstrated knowledge of constructive methods for channeling/controlling emotional reactions and the ability to provide emotional reactions in a positive, constructive manner. ~~All activities were completed in a reasonable time frame~~.

Occupation: General Electronics Technician

Proficiency Area: Desirable Behavior and Work Habits

B. **Interpersonal Relationships**

Skill: B.04 Recognize problems and work toward their solution

MEASUREMENT CRITERIA

1. Explained how a work related problem stems from multiple sources/situations that effect the solution.

2. Emphasized how one problem has several solutions.

3. Identified methods for effective problem solving on the job.

4. Listed advantages of resolving problems in a cooperative way.

5. Described the level of behavior needed to resolve conflict in a professional way.

6. Analyzed a problem situation an electronic technicians encounters and determined appropriate steps to resolve the problem.

RESULTS:

Demonstrated knowledge of problem solving methods and the ability to identify a problem situation and initiate and an effective solution in a positive, constructive manner. All activities were completed in a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Desirable Behavior and Work Habits

**B. Interpersonal Relationships**

Skill: B.05 Exhibit positive behavior

MEASUREMENT CRITERIA

1. Explained how positive work behavior improves the work environment.
2. Interpreted how worker behavior has positive or negative effects on co-workers.
3. Emphasized how worker attitudes effect worker performance and safety.
4. Identified methods for effectively exhibiting positive work behavior.
5. Listed ways in which an electronics technician exhibits positive behavior on the job.
6. Analyzed work situations in which the electronics technician's behavior/attitudes effects the outcome of the situation.

RESULTS:

Demonstrated knowledge of the importance of positive behavior and the ability to exhibit positive behavior in different work situations. ~~All activities were completed in a reasonable time frame~~.

Occupation: General Electronics Technician

Proficiency Area: Desirable Behavior and Work Habits

**B. Interpersonal Relationships**

Skill: B.06 Exhibit sensitivity to internal and external customer needs

MEASUREMENT CRITERIA

1. Defined the difference between internal and external customer needs.

2. Explained how exhibiting sensitivity to customer needs is important to the company and customer relations.

3. Identified situations in which an electronics technician would be required to exhibit sensitivity to customer needs.

4. Listed methods for exhibiting sensitivity to work situations concerning customer needs.

5. Emphasized the importance of electronics technicians exhibiting sensitivity to customer needs.

6. Listed examples of internal and external customer needs.

RESULTS:

Demonstrated knowledge of customer needs and the ability to exhibit sensitivity to customer's internal and external needs. All activities were completed in a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Desirable Behavior and Work Habits

**B. Interpersonal Relationships**

Skill: B.07 Treat people with respect

MEASUREMENT CRITERIA

~~1. Explained ethical, social, and legal responsibilities for dealing with interpersonal relationships.~~

2. ~~Emphasized~~ Explained the difference between respectful behavior and disrespectful behavior.

~~3. Listed benefits of respectful behavior in the workplace.~~

4. Identified work situations in which an electronics technician displays respect.

RESULTS:

Demonstrated knowledge of respectful behavior and the ability to treat people with respect in varying work situations. ~~All activities were completed in a reasonable time frame.~~

Occupation: General Electronics Technician

Proficiency Area: Desirable Behavior and Work Habits

**B. Interpersonal Relationships**

Skill: B.08 Recognize non-verbal communication

MEASUREMENT CRITERIA

1. Named methods for communicating non-verbally.
2. Listed positive and negative cues given by body language.
3. Identified types of non-verbal communication encountered ~~by electronics technicians on the job.~~
4. ~~Explained~~ how to recognize non-verbal communication and interpret its meaning.
5. ~~Emphasized~~ Explained how body language can override verbal communication.
6. Evaluated body language exhibited during the completion of a task and explained the effect of this non-verbal communication.

RESULTS:

Demonstrated knowledge and importance of non-verbal communication ~~and the ability to identify, interpret and respond to non-verbal communication in the workplace. All activities were completed in a reasonable time frame.~~

Occupation: General Electronics Technician

Proficiency Area: Desirable Behavior and Work Habits

C. Teamwork

Skill: C.01 Understand interactive relationships required for effective teamwork

MEASUREMENT CRITERIA

1. Identified styles of leadership used in effective teams.

2. Described the roles necessary to perform a team task.

3. Explained the need and importance of communication in effective teamwork situations.

4. Observed teams ~~involving electronics technicians~~ at work and evaluated the roles of each team member.

5. Listed teamwork situations and roles that ~~an~~ electronics technician~~s~~ are encounter~~s~~ed on the job.

6. ~~Emphasized~~ Explained the importance of team members completing responsibilities in a timely and efficient manner.

RESULTS:

Demonstrated knowledge of effective teamwork procedures and the ability to maintain interactive relationships necessary for effective teamwork. ~~All activities were completed in a reasonable time frame.~~

Occupation: General Electronics Technician

Proficiency Area: Desirable Behavior and Work Habits

C. **Teamwork**

Skill: C.02 Understand team's operating procedures

MEASUREMENT CRITERIA

1. Specified the advantages for using teamwork to complete a task.
2. Pointed out different methods/procedures for operating a team.
3. Identified team member roles required to operate effectively as a team.
4. Emphasized the importance of all team members completing assigned responsibilities.
5. Explained reasons why working as a team is beneficial.
6. Listed situations in which ~~electronics technicians~~ employees would be involved as part of a team.

RESULTS:

Demonstrated knowledge of team operational procedures and the ability to function successfully as part of a team. ~~All activities were completed in a reasonable time frame.~~

Occupation: General Electronics Technician

Proficiency Area: Desirable Behavior and Work Habits

C. **Teamwork**

Skill: C.03 Adapt as necessary to complete the team task

MEASUREMENT CRITERIA

1. Described how team roles can overlap and situations that require a redistribution of team responsibilities.
2. Explained how ~~Emphasized~~ the importance of maintaining deadlines to ensure the whole team's success.
3. Explained the "shared efforts leads to shared rewards" concept.
4. Identified situations that require adaptation by a team to ensure the team's success.

RESULTS:

Demonstrated knowledge of teamwork procedures and the ability to identify the need for procedural adaptation and institute team changes necessary for successful team task completion. ~~All activities were completed in reasonable time frame.~~

Occupation: General Electronics Technician

Proficiency Area: Desirable Behavior and Work Habits

C. Teamwork

Skill: C.04 Evaluate outcome

MEASUREMENT CRITERIA

1. Explained the need for comparing desired project goals to the project's outcome to evaluate the success of a team project.
2. Identified methods for evaluating the outcome of a team project.
3. Emphasized the importance of evaluating a team project outcome as reference for future projects.
4. Analyzed team project goals and outcomes to establish the success or failure of the project.

RESULTS:

Demonstrated knowledge of the procedures for evaluating team's project outcomes and the ability to determine if the outcome fulfilled the desired team project goals. All activities were completed in a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Additional Skills

A. Communication

B. Electromechanics

C. Lasers

Occupation: General Electronics Technician

Proficiency Area: Additional Skills

**A. Communication**

Skill: A.01 Transmission line applications

MEASUREMENT CRITERIA

1. Described various types of transmission lines.

2. Identified the type of transmission line and enhancement devices to be used in various situations.

RESULTS:

Demonstrated knowledge of communication by describing the basics of transmission line applications.

Occupation: General Electronics Technician

**A. Communication**

Skill: A.02 Antenna systems

MEASUREMENT CRITERIA

1. Explained the significance of the antenna system to a communications circuit.

2. Listed various types of antennas.

RESULTS:

Demonstrated knowledge of antenna systems by describing the basics of transmission systems including transmitting and receiving antenna systems.

Occupation: General Electronics Technician

Proficiency Area: Additional Skills

**A. Communication**

Skill: A.03 Types of multiplexing systems

MEASUREMENT CRITERIA

1. Described how multiplex transmission is achieved.

2. Identified methods of multiplex transmission.

   A. Frequency-division multiplex
   B. Time-division multiplex

RESULTS:

Demonstrated knowledge of types of multiplexing systems by describing the basics of multiplexing systems.

Occupation: General Electronics Technician

Proficiency Area: Additional Skills

**A. Communication**

Skill: A.04 Data Communications ~~Systems~~

MEASUREMENT CRITERIA

1. Described the various systems used in data communications.

2. Listed and explained the advantages and disadvantages of each method for transferring data.

   A. Analog
   B. Digital

3. Described concepts and applications of error detection and correction.

4. Described the concepts and applications of data compression and decompression.

RESULTS:

Demonstrated knowledge of data communication by describing the basics of data communications systems.

Occupation: General Electronics Technician

Proficiency Area: Additional Skills

**A. Communication**

Skill: A.05 Types of telephone switching systems

MEASUREMENT CRITERIA

1. Explained the functions of switching networks.

2. Described the various types and service availabilities of switching networks.

3. Described features available for linking individuals.

RESULTS:

Demonstrated knowledge of telephone switching systems by completing each activity.

Occupation: General Electronics Technician

Proficiency Area: Additional Skills

**A. Communication**

Skill: A.06 Microwave communication systems

MEASUREMENT CRITERIA

1. Explained the functioning of microwave communications, including advantages and disadvantages.

2. Described safety procedures for avoiding exposure to microwaves.

~~3. Applied knowledge of microwaves to an explanation of microwave repeaters~~.

3 4. Described basics of satellite communication systems.

RESULTS:

Demonstrated knowledge of microwave communication systems by completing each of the identified activities.

Occupation: General Electronics Technician

Proficiency Area: Additional Skills

B. **Electromechanics**

Skill: B.01 Servomechanisms, motors, and motor control circuits

MEASUREMENT CRITERIA

1. Explained the principles/theory of servomechanisms, motors, and motor control circuits.

2. Listed applications of servomechanisms, motors, and motor control circuits.

3. Described open and closed loop control systems.

RESULTS:

Demonstrated understanding of servomechanisms, motors, and motor control circuits, pneumatic and mechanical power sources by completing each of the activities.

Occupation: General Electronics Technician

Proficiency Area: Additional Skills

B. **Electromechanics**

Skill: B.02 Hydraulic and pneumatic systems

MEASUREMENT CRITERIA

1. Explained the principles/theory of hydraulic and pneumatic systems to Electromechanics.

2. Listed applications of hydraulic and pneumatic systems in Electromechanics.

RESULTS:

Demonstrated basic understanding of hydraulic and pneumatic systems by completing each of the activities.

Occupation: General Electronics Technician

Proficiency Area: Additional Skills

B. Electromechanics

Skill: B.03 Mechanical power transmission systems

MEASUREMENT CRITERIA

1. Explained the principles/theory of the operation of mechanical power transmission systems.

2. Listed applications of mechanical power transmission systems.

RESULTS:

Demonstrated basic understanding of mechanical power transmission systems by completing each activity.

Occupation: General Electronics Technician

Proficiency Area: Additional Skills

B. **Electromechanics**

Skill: B.04 Vacuum systems and components

MEASUREMENT CRITERIA

1. Explained the principles/theory of operation of vacuum systems and components.

2. Listed types and applications of vacuum systems and components.

RESULTS:

Demonstrated basic understanding of vacuum systems and components by completing each activity.

Occupation: General Electronics Technician

Proficiency Area: Additional Skills

**B. Electromechanics**

Skill: B.05 Mechanisms, linkages and levers

MEASUREMENT CRITERIA

1. Explained the principles/theory of mechanisms, linkages and levers.

2. Listed types and applications of mechanisms, linkages and levers.

RESULTS:

Demonstrated basic understanding of mechanisms, linkages, and levers by completing each activity.

Occupation: General Electronics Technician

Proficiency Area: Additional Skills

**B. Electromechanics**

Skill: B.06 Transducers and instrumentation

MEASUREMENT CRITERIA

1. Explain the principles/theory of transducers and instrumentation.

2. Listed types and applications of transducers.

3. Listed types and uses of instrumentation.

RESULTS:

Demonstrated basic understanding of transducers and instrumentation systems by completing each activity.

Occupation: General Electronics Technician

Proficiency Area: Additional Skills

**B. Electromechanics**

Skill: B.07 Industrial materials

MEASUREMENT CRITERIA

1. Described the regulatory process for dealing with hazardous material.

2. Followed manufacturer's directions for the handling and disposal of all industrial materials.

3. Described representative safety needs and practices.

RESULTS:

Demonstrated basic understanding of safe use of industrial materials by the completion of each activity. Accepted safety, fabrication, and measurement procedures were followed.

Occupation: General Electronics Technician

Proficiency Area: Additional Skills

**B. Electromechanics**

Skill: B.08 Automatic controls and robotics

MEASUREMENT CRITERIA

1. Described the main components of robotics and automatic controls.

RESULTS:

Demonstrated knowledge of automatic controls and robotics by completion of the activity.

Occupation: General Electronics Technician

Proficiency Area: Additional Skills

C. Lasers

Skill: C.01 Welding, cutting and drilling

MEASUREMENT CRITERIA

1. Described use of lasers in welding, cutting, and drilling.

2. Explained safety concerns in the use of lasers in welding, cutting, and drilling.

3. Listed general applications of lasers used in welding, cutting, and drilling.

4. Observed lasers in use in welding, cutting, and drilling when feasible.

RESULTS:

Demonstrated knowledge of the application of lasers involved in welding, cutting, and drilling by the completion of each activity.

Occupation: General Electronics Technician

Proficiency Area: Additional Skills

**C. Lasers**

Skill: C.02 Data recording and manipulation

MEASUREMENT CRITERIA

1. Described the use of lasers in data recording and manipulation.

2. Explained safety concerns in the use of lasers in data recording and manipulation.

3. Listed general applications of lasers used in data recording and manipulation.

4. Observed lasers in use in data recording and manipulation.

RESULTS:

Demonstrated knowledge of the application of lasers involved in data recording and manipulation by the completion of each activity.

Occupation: General Electronics Technician

Proficiency Area: Additional Skills

C. Lasers

Skill: C.03 Environmental testing and monitoring

MEASUREMENT CRITERIA

1. Described the use of lasers in environmental testing and monitoring.

2. Explained safety concerns in the use of lasers in environmental testing and monitoring.

3. Listed general applications of lasers used in environmental testing and monitoring.

4. Observed lasers in use in environmental testing and monitoring when feasible.

RESULTS:

Demonstrated knowledge of the application of lasers involved in environmental testing and monitoring by the completion of each activity.

Occupation: General Electronics Technician

Proficiency Area: Additional Skills

C. Lasers

Skill: C.04 Nondestructive testing

MEASUREMENT CRITERIA

1. Described the use of lasers in nondestructive testing.

2. Explained safety concerns in the use of lasers in nondestructive testing.

3. Listed general applications of lasers used in nondestructive testing.

4. Observed lasers in use in nondestructive testing when feasible.

RESULTS:

Demonstrated knowledge of the application of lasers involved in nondestructive testing by the completion of each activity.

Occupation: General Electronics Technician

Proficiency Area: Additional Skills

C. Lasers

Skill: C.05 Measurement

MEASUREMENT CRITERIA

1. Described the use of lasers in measurement.

2. Explained safety concerns in the use of lasers in measurement.

3. Listed general applications of lasers used in measurement.

4. Observed lasers in use in measurement when feasible.

RESULTS:

Demonstrated knowledge of the application of lasers involved in measurement by the completion of each activity.

Occupation: General Electronics Technician

Proficiency Area: Additional Skills

**C. Lasers**

Skill: C.06 Communications

MEASUREMENT CRITERIA

1. Described the use of lasers in communications.

2. Explained safety concerns in the use of lasers in communications.

3. Listed general applications of lasers used in communications.

4. Observed lasers in use in communications when feasible.

RESULTS:

Demonstrated knowledge of the application of lasers involved in communications by the completion of each activity.

Occupation: General Electronics Technician

Proficiency Area: Additional Skills

C. Lasers

Skill: C.07 Fiber optics and lasers

MEASUREMENT CRITERIA

1. Described the use of lasers in fiber optics.

2. Explained safety concerns in the use of lasers in fiber optics.

3. Listed general applications of lasers used in fiber optics.

4. Observed lasers in use in fiber optics when feasible.

RESULTS:

Demonstrated knowledge of the application of lasers involved in fiber optics by the completion of each activity.

Occupation: General Electronics Technician

Proficiency Area: Additional Skills

**C. Lasers**

Skill: C.08 Lasers in medicine

MEASUREMENT CRITERIA

1. Described the use of lasers in medicine.

2. Explained safety concerns in the use of lasers in medicine.

3. Listed general applications of lasers used in medicine.

4. Observed lasers in use in medicine when feasible.

RESULTS:

Demonstrated knowledge of the application of lasers involved in medicine by the completion of each activity.

Occupation: General Electronics Technician

Proficiency Area: Additional Skills

C. Lasers

Skill: C.09 Holography/interferometer

MEASUREMENT CRITERIA

1. Described the use of lasers in holography/interferometer.

2. Explained safety concerns in the use of lasers in holography/interferometer.

3. Listed general applications of lasers used in holography/interferometer.

4. Observed lasers in use in holography/interferometer when feasible.

RESULTS:

Demonstrated knowledge of the application of lasers involved in holography/interferometer by the completion of each activity.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

**A. Technical Literacy**

Skill: A.01 Demonstrate basic keyboarding skills

MEASUREMENT CRITERIA

1. Demonstrated use of keyboard to produce text and to control specified computer functions.

2. Demonstrated ability to keyboard at a rate of 20 wpm with ~~5 errors~~ 2 V 10 70 maximum.

3. Explained the difference between keyboarding and other data entry devices.

RESULTS:

Demonstrated knowledge of keyboarding and other data entry devices by the completion of each activity. Information was correctly stored in the computer. The work was completed within a reasonable time frame as determined by the instructor.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

**A. Technical Literacy**

Skill: A.02 Demonstrate ability to use standard applications software such as word processors, database management, and spreadsheets

MEASUREMENT CRITERIA

1. Performed editing using word processing.
2. Entered information into an established data base, retrieved records from the data base.
3. Set up a spreadsheet to be used in recording information.
4. Reproduced an electronic circuit using a sketching applications program.
5. Accessed remote network using a communication software.

RESULTS:

Demonstrated knowledge of standard applications of software such as word processors, database management and spreadsheets by the completion of each activity. Accepted keyboarding procedures were followed. All work was completed within a reasonable time frame, and by the instructor

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

**A. Technical Literacy**

Skill: A.03 Maintain state-of-the-art skills through participation in in-service or other training

MEASUREMENT CRITERIA

1. Explained the need to stay up-to-date with technological changes related to the electronics field.

2. Identified publications available to provide technical information and information regarding training programs.

3. Located ~~local~~ electronics associations to identify changes taking place in the field.

~~4. Attended professional meetings of the electronics technicians.~~

RESULTS:

Demonstrated an understanding of the need to maintain state-of-the-art skills through participation in in-service or other training by the completion of each activity.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

**A. Technical Literacy**

Skill: A.04 Participate in continuing education

MEASUREMENT CRITERIA

1. Explained the need to continuously improve work skills through education.

2. Listed sources of continuing education classes.

RESULTS:

Demonstrated an awareness of the need to continue education through the completion of each activity.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

**A. Technical Literacy**

Skill: A.05 Understand and apply continuous improvement principles (see data analysis)

MEASUREMENT CRITERIA

1. Described continuous improvement principles.

2. Provided examples demonstrating an understanding of continuous improvement principles.

3. Organized data into graphs or charts as needed.

4. Interpreted information from statistical information for purpose of improvement of processes/functions.

RESULTS:

Knowledge of continuous improvement processes was demonstrated through completion of each activity.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

**A. Technical Literacy**

Skill: A.06 Demonstrate knowledge of the business products/services

MEASUREMENT CRITERIA

1. Explained the importance of being knowledgeable about business products/services.

2. Listed ways of obtaining information about products/services.

RESULTS:

Demonstrated knowledge of business products/services by the completion of each activity.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

B. **Communicating on the Job**

Skill: B.01 Use effective written and other communication skills

MEASUREMENT CRITERIA

1. Followed direction for the completion of a task.
2. Completed the task without error.
3. Developed a written procedure for a technical process.
4. Provided an oral presentation describing a technical issue or process.
5. Demonstrated effective communication using written, verbal and non-verbal forms of communication.

RESULTS:

Demonstrated the ability to communicate effectively by the completion of each activity.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

**B. Communicating on the Job**

Skill: B.02 Use telephone etiquette including relaying messages accurately

MEASUREMENT CRITERIA

1. Described the importance of the telephone to business success.
2. Listed rules of etiquette for using the telephone.
3. Explained the procedure for recording a business message.

RESULTS:

Demonstrated the ability to apply telephone etiquette when answering the telephone and relaying messages by the completion of each activity.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

B. **Communicating on the Job**

Skill: B.03 Employ appropriate skills for gathering and retaining information

MEASUREMENT CRITERIA

1. Demonstrated ability to gather information by written and verbal means.

2. Demonstrated ability to interpret written and verbal information.

3. Contacted appropriate persons for pertinent information.

4. Maintained documentation of information gathered.

RESULTS:

Demonstrated ability to identify, locate, gather, and retain information by completion of each activity.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

B. **Communicating on the Job**

Skill: B.04 Interpret written, graphic and oral instructions

MEASUREMENT CRITERIA

1. Identified types of written, graphic and oral instructions and when they are used.

2. Interpreted written, oral and graphic instructions.

3. Described how to ask for clarification when giving or receiving instructions.

4. Demonstrated how to interpret graphic information.

5. Explained the importance of listening to complete instructions.

6. Illustrated the understanding of body language in interpreting oral directions.

RESULTS:

Demonstrated the ability to interpret written, graphic and oral instructions by the completion of each activity.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

**B. Communicating on the Job**

Skill: B.05 Interact with co-workers and customers in a logical, clear and understandable manner

MEASUREMENT CRITERIA

1. Demonstrated the different requirements when communicating with management, co-workers, and customers.

2. Interpreted body language in the communication process.

3. Demonstrated proper listening skills when communicating with co-workers and customers.

4. Described the effect of word stress and voice tone when communicating.

5. Demonstrated proper recording and relaying messages in a clear and concise manner.

RESULTS:

Demonstrated the ability to communicate in a logical, clear and understandable manner by the completion of each activity.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

**B. Communicating on the Job**

Skill: B.06 Use language appropriate to the situation

MEASUREMENT CRITERIA

1. Demonstrated use of appropriate job-specific terminology to describe work situation.

2. Defined job-specific words to customers when needed.

3. Communicated orally to customers avoiding derogatory, insulting and slang terminology.

4. Addressed co-workers and supervisors appropriately.

RESULTS:

Demonstrated use of appropriate language for designated situations in each activity. as det by instr.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

B. **Communicating on the Job**

Skill: B.07 Participate in meeting in a positive and constructive manner

MEASUREMENT CRITERIA

1. Listed different kinds of business meetings.
2. Explained the roles of individuals in business meetings.
3. Participated appropriately in a mock business meeting.
4. Described the difference between positive and non-constructive meeting participation.

RESULTS:

Demonstrated the ability to participate in a meeting ~~on~~ in a positive and constructive manner by the completion of each activity.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

**B. Communicating on the Job**

Skill: B.08 Use job-related terminology

MEASUREMENT CRITERIA

1. Explained job-related terminology in the electronics technician field in use with other electronics personnel.

RESULTS:

Demonstrated the ability to understand and use job related terminology in an appropriate situation by the completion of each activity.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

**B. Communicating on the Job**

Skill: B.09 Write technical reports, letters and memoranda as appropriate to the audience (e.g., management, customers, co-workers, and manufacturers)

MEASUREMENT CRITERIA

1. Followed basic format of business letters and memoranda to construct appropriate written material.

2. Used correct format and language in preparing technical reports for electronic technicians.

3. Explained how to modify written communications for different audiences(e.g. management, customers, co-workers and manufacturers).

4. Developed examples of various types of business communications.

RESULTS:

Demonstrated ability to write various technical reports, letters and memoranda to and for different audiences. All activities were completed within a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

B. **Communicating on the Job**

Skill: B.10 Document work projects, procedures, tests, and equipment failures

MEASUREMENT CRITERIA

1. Demonstrated proficiency in documenting work projects and procedures using appropriate methods.

2. Explained test documentation procedures.

3. Provided documentation tracking equipment failures, listing procedures used and test results to determine equipment failure.

RESULTS:

Demonstrated ability to appropriately document projects, procedures and equipment failures. All activities were completed within a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

**C. Solving Problems and Critical Thinking**

Skill: C.01 Identify the problem

MEASUREMENT CRITERIA

1. Explained how attitudes, beliefs and values influence perception of problems.

2. Determined that there was a problem in a given set of conditions.

3. Explained the process used to identify the problem.

RESULTS:

Demonstrated the ability to identify the problem by the completion of each activity. These activities were completed in a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

**C. Solving Problems and Critical Thinking**

Skill: C.02 Clarify purposes and goals

MEASUREMENT CRITERIA

1. Described goals and how they are affected by people, objects, or ideas.

2. Described factors that impacted problem and solution.

3. Developed statement of goals for problem solution.

RESULTS:

Demonstrated the ability to clarify purposes and goals by the completion of each activity. These activities were completed within a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

**C. Solving Problems and Critical Thinking**

Skill: C.03 Identify available solutions and their impact including evaluating credibility of information, and locating information

MEASUREMENT CRITERIA

1. Interpreted possible solution to a hypothetical problem and discussed possible impact of each solution.

2. Described several solutions to a hypothetical problem.

3. Identified possible sources of information for the resolution of a problem and determined the credibility of the information.

RESULTS:

Demonstrated the ability to identify solutions to problems and identify the impact of the solution by the completion of each activity. These activities were completed in a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

**C. Solving Problems and Critical Thinking**

Skill: C.04 Evaluate options

MEASUREMENT CRITERIA

1. Described how to analyze options.
2. Explained how different methods of solving problems will have different results.
3. ~~Contrasted~~ Compared different options and explained how to test and choose best option for any given situation.
4. Listed the possible solutions to a problem and evaluated each solution to determine the best option.
5. Described criteria for making choice of option.

RESULTS:

Demonstrated the ability to evaluate a problem and arrive at the best option for solving the problem by the completion of each activity. These activities were completed in a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

**C. Solving Problems and Critical Thinking**

Skill: C.05 Set priorities

MEASUREMENT CRITERIA

1. Defined priorities.

2. Listed external and internal forces that effect the establishment of priorities.

   a. Values
   b. Attitudes
   c. Environment
   d. Other business factors

3. Prioritized a list of tasks and explained the reasons for prioritizing that way.

RESULTS:

Demonstrated the ability to set priorities by the completion of each activity. These activities were completed in a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

**C. Solving Problems and Critical Thinking**

Skill: C.06 Select/implement options/decisions including predicting results of proposed action

MEASUREMENT CRITERIA

1. Selected solution to the problem.

2. Described anticipated results of the solution.

3. Explained why the solution was selected.

RESULTS:

Demonstrated the ability to select and implement an option for the solution of a problem along with predicting the result of the action selected by the completion of each activity. The activities were completed in a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

**C. Solving Problems and Critical Thinking**

Skill: C.07 Organize personal workloads

MEASUREMENT CRITERIA

1. Described the need to ~~apply critical thinking to~~ plan~~ning~~ the organization of workloads.

2. Listed reasons for the organization of a hypothetical workload.

3. Organized workload by:

   a. Work you must do
   b. Work assigned to others
   c. Work that must be done immediately
   d. Work that can wait
   e. Work that you would like to accomplish

RESULTS:

Demonstrated the ability to organize personal workloads by the completion of each activity. These activities were completed within a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

**C. Solving Problems and Critical Thinking**

Skill: C.08 Participate in brainstorming sessions to generate new ideas and solve problems

MEASUREMENT CRITERIA

1. Demonstrated appropriate team member behavior in group brainstorming session.

2. Identified potential new ideas and solutions to problems.

3. Explained how brainstorming teamwork creates new ideas for team problems.

4. Participated as a group member and leader in a brainstorming session.

RESULTS:

Demonstrated appropriate group roles in brainstorming sessions that produced new ideas for problems. The activities were completed in a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

D. Reading

Skill: D.01 Read and apply various sources of technical information (e.g., manufacturer literature, codes and regulations)

MEASUREMENT CRITERIA

1. Identified appropriate information from technical literature.

2. Identified appropriate sections of codes and regulations for electronics technician.

3. Demonstrated proficiency in reading codes and regulations pertinent to electronics technician.

4. Interpreted and applied information found in technical literature, codes and regulations.

RESULTS: and interpret, and apply

Demonstrated ability to read manufacturer's literature, codes and regulations by completing the activities. All activities were performed within a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

**E. Proficiency in Mathematics**

Skill: E.01 Determine if a solution is reasonable

MEASUREMENT CRITERIA

1. Demonstrated estimating ability

2. Demonstrated ability to select the most reasonable solution from several options.

RESULTS:

Demonstrated knowledge of estimating solutions by the completion of each activity. Appropriate number relations, measurements, analysis and math applications were applied to each activity. All activities were completed in a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

**E. Proficiency in Mathematics**

Skill: E.02 Demonstrate ability to use a simple electronic calculator

MEASUREMENT CRITERIA

1. Performed all calculations necesary for all appropriate mathematical functions.

RESULTS:

Demonstrated knowledge of the use of the calculator by the completion of this activity.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

**E. Proficiency in Mathematics**

Skill: E.03 Round and/or truncate numbers to designated place value

MEASUREMENT CRITERIA

1. Rounded numbers to designated place value.

2. Identified integer value of numbers.

3. Truncated numbers to designated number of decimals.

RESULTS:

Demonstrated knowledge of rounding and truncating numbers by the completion of each activity. All calculations were completed without error. All activities were completed in a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

**E. Proficiency in Mathematics**

Skill: E.04. Compare, order and determine equivalencies of real numbers(e.g., fractions, decimals, percentages)

MEASUREMENT CRITERIA

1. Rank ordered a set of decimal numbers.
2. Rank ordered a set of fractions.
3. Rank ordered a set of percentages.
4. Rank ordered a set containing mixed fractions, decimals, and percentages.
5. Compared fractions, decimals and percentages to determine their equivalency.
6. Converted a set of fractions to their decimal equivalents.
7. Converted a set of fractions to their percentage equivalents.
8. Converted a set of decimal numbers to their fractional equivalents.
9. Converted a set of decimal numbers to their percentage equivalents.
10. Converted a set of percentages to their decimal equivalents.
11. Converted a set of percentages to their fractional equivalents.

RESULTS:

Demonstrated knowledge of real number equivalencies by the completion of each activity. All calculations were completed without error. Appropriate number relations, measurements, analysis and math applications were applied to each activity. All activities were completed in a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

**E. Proficiency in Mathematics**

Skill: E.05 Solve problems and make applications involving integers, fractions, decimals, percentages and ratios using order of operations

MEASUREMENT CRITERIA

1. Defined the order of operations in an equation.

2. Solved equations involving several different operations (i.e., parentheses, multiplication, division).

3. Solved equations involving different forms of numbers (i.e., integers, fractions, decimals, percentages) by performing operations in correct order.

RESULTS:

Demonstrated knowledge of integers, fractions, decimals, and percentages by the completion of each activity. All calculations were completed without error. Appropriate number relations, measurements, analysis and math applications were applied to each activity. All activities were completed in a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

**E. Proficiency in Mathematics**

Skill: E.06. Translate written and/or verbal statements into mathematical formulas

MEASUREMENT CRITERIA

1. Translated verbal statements of problems into appropriate mathematical formulas.

2. Translated written statements of problems into appropriate mathematical formulas.

RESULTS:

Demonstrated knowledge of conversion of verbal and written statemenmts into mathematical formulas by the completion of each activity. All calculations were completed without error. Appropriate number relations, measurements, analysis and math applications were applied to each activity. All activities were completed in a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

**E. Proficiency in Mathematics**

Skill: E.07 Compare, compute, and solve problems involving binary, octal, decimal, and hexadecimal numbering systems

MEASUREMENT CRITERIA

1. Defined "binary numbering system".
2. Defined "octal numbering system".
3. Defined "decimal numbering system".
4. Defined "hexadecimal numbering system".
5. Converted binary numbers to their equivalent in octal, decimal and hexadecimal systems.
6. Converted octal numbers to their equivalent in binary, decimal and hexadecimal systems.
7. Converted decimal numbers to their equivalent in binary, octal and hexadecimal systems.
8. Converted hexadecimal numbers to their equivalent in binary, octal, decimal systems.
10. Performed addition and subtraction involving numbers in octal form.
11. Performed addition and subtraction involving numbers in decimal form.
12. Performed addition and subtraction involving numbers in hexadecimal form.

RESULTS:

Demonstrated knowledge of binary, octal, decimal, and hexadecimal numbering by the completion of each activity. All calculations were completed without error. Appropriate number relations, measurements, analysis and math applications were applied to each activity. All activities were completed in a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

**E. Proficiency in Mathematics**

Skill: E.08 Convert, compare and compute with common units of measurement within and across measurement systems

MEASUREMENT CRITERIA

1. Converted measurements from metric to English system.
2. Converted measurements from English to metric system.
3. Compared measurements to determine equivalency.
4. Solved problems involving measurements in metric system.
5. Solved problems involving measurements in English system.
6. Solved problems involving measurements from both systems in same statement.
7. Converted temperatures equations.

RESULTS:

Demonstrated knowledge of measurement systems by the completion of each activity. All calculations were completed without error. Appropriate number relations, measurements, analysis and math applications were applied to each activity. All activities were completed in a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

**E. Proficiency in Mathematics**

Skill: E.09 Read scale on measurement devices and make interpolations where appropriate

MEASUREMENT CRITERIA

1. Demonstrated ability to correctly measure electrical values using various devices (i.e., meters, scopes).

2. Demonstrated ability to interpolate.

RESULTS:

Demonstrated knowledge of scales on measurement devices by the completion of each activity. All calculations were completed without error. Appropriate number relations, measurements, analysis and math applications were applied to each activity. All activities were completed in a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

**E. Proficiency in Mathematics**

Skill: E.10 Understand statistical terms and charts needed for interpretation of continuous improvement processes

MEASUREMENT CRITERIA

1. Defined commonly used statistical terms.
2. Described and demonstrated use of histogram.
3. Described and demonstrated use of Pareto diagram.
4. Described and demonstrated use of Bar chart.
5. Described and demonstrated use of Pie chart.
6. Described and demonstrated use of Run chart.
7. Described and demonstrated use of scatter diagram.

RESULTS:

Demonstrated knowledge of statistical terms and charts for continuous improvement process by the completion of each activity. All calculations were completed without error. Appropriate number relations, measurements, analysis and math applications were applied to each activity. All activities were completed in a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

**E. Proficiency in Mathematics**

Skill: E.11 Collect and organize data into tables, charts and/or graphs

MEASUREMENT CRITERIA

1. Used a data collection tool.
2. Described processes for collecting data using the data collection tool.
3. Prepared a table from a set of data.
4. Prepared a chart from a set of data.
5. Prepared a graph from a set of data.

RESULTS:

Demonstrated knowledge of tables, charts, and graphs by the completion of each activity. All calculations were completed without error. Appropriate number relations, measurements, analysis and math applications were applied to each activity. All activities were completed in a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

**E. Proficiency in Mathematics**

Skill: E.12 Interpret and use tables, charts, maps and/or graphs

MEASUREMENT CRITERIA

1. Interpreted and described the use of a table.
2. Interpreted and described the use of a chart.
3. Interpreted and described the use of a map.
4. Interpreted and described the use of a graph.
5. Compared uses, differences, and applicability of each.

RESULTS:

Demonstrated knowledge of use and interpretation of tables, charts, maps, and graphs by the completion of each activity. All calculations were completed without ~~error~~ error. Appropriate number relations, measurements, analysis and math applications were applied to each activity. All activities were completed in a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

**E. Proficiency in Mathematics**

Skill: E.13 Identify patterns, note trends, and/or draw conclusions from tables, charts, maps and/or graphs

MEASUREMENT CRITERIA

1. Identified patterns and/or trends from a table.
2. Identified patterns and/or trends from a chart.
3. Identified patterns and/or trends from a map.
4. Identified patterns and/or trends from a graph.
5. Drew logical conclusions from pattern or trend identified.

RESULTS:

Demonstrated ability to identify patterns, note trends, and draw conclusions from tables, charts, maps, and graphs by the completion of each activity. All calculations were completed without ~~real~~ error. Appropriate number relations, measurements, analysis and math applications were applied to each activity. All activities were completed in a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

**E. Proficiency in Mathematics**

Skill: E.15 Simplify and solve algebraic expressions and formulas

MEASUREMENT CRITERIA

1. Simplified algebraic expressions.

2. Solved algebraic formulas.

RESULTS:

Demonstrated knowledge of algebraic expressions and formulas by the completion of each activity. All calculations were completed without error. Appropriate number relations, measurements, analysis and math applications were applied to each activity. All activities were completed in a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

**E. Proficiency in Mathematics**

Skill: E.16 Select and use formulas appropriately

MEASUREMENT CRITERIA

1. Selected an appropriate formula to solve a problem.

2. Demonstrated use of an appropriate formula to solve a problem.

RESULTS:

Demonstrated ability to select and use formulas by the completion of each activity. All calculations were completed without error. Appropriate number relations, measurements, analysis and math applications were applied to each activity. All activities were completed in a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

**E. Proficiency in Mathematics**

Skill: E.17 Understand and use scientific notation

MEASUREMENT CRITERIA

1. Defined "scientific notation".
2. Converted numbers from scientific notation to decimal notation.
3. Converted numbers from decimal notation to scientific notation.
4. Performed multiplication using scientific notation.
5. Performed addition using scientific notation.
6. Performed division using scientific notation.
7. Performed subtraction using scientific notation.

RESULTS:

Demonstrated an understanding and use of scientific notation by the completion of each activity. All calculations were completed without error. Appropriate number relations, measurements, analysis and math applications were applied to each activity. All activities were completed in a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

**E. Proficiency in Mathematics**

Skill: E.18 Use properties of exponents and logarithms

MEASUREMENT CRITERIA

1. Defined commonly used terms.

2. Demonstrated use of exponents to solve problems.

3. Demonstrated use of logarithms to solve problems.

4. Demonstrated use of common and natural logarithms.

RESULTS:

Demonstrated knowledge of the properties of exponents and logarithms by the completion of each activity. All calculations were completed without error. Appropriate number relations, measurements, analysis and math applications were applied to each activity. All activities were completed in a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

**E. Proficiency in Mathematics**

Skill: E.19 Determine slope, midpoint and distance

MEASUREMENT CRITERIA

1. Defined "slope".
2. Defined "midpoint".
3. Defined "distance of a point from a line".
4. Determined the slope of a graph.
5. Determined the slope from an algebraic equation.
6. Determined the midpoint.
7. Determined the distance of a point from a line.

RESULTS:

Demonstrated ability to determine slope, midpoint, and distance by the completion of each activity. All calculations were completed without error. Appropriate number relations, measurements, analysis and math applications were applied to each activity. All activities were completed in a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

**E. Proficiency in Mathematics**

Skill: E.20 Graph functions

MEASUREMENT CRITERIA

1. Drew graphs of specified mathematical ~~statements~~ functions relevant to electronics.

RESULTS:

Demonstrated knowledge of graph functions by the completion of each activity. All calculations were completed without error. Appropriate number relations, measurements, analysis and math applications were applied to each activity. All activities were completed in a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

**E. Proficiency in Mathematics**

Skill: E.21 Use Boolean algebra to break down logic circuits

MEASUREMENT CRITERIA

1. Defined Boolean algebra.

2. Used Boolean algebra to describe commonly used logic circuits.

RESULTS:

Demonstrated knowledge of Boolean algebra to break down logic circuits by the completion of each activity. All calculations were completed without error. Appropriate number relations, measurements, analysis and math applications were applied to each activity. All activities were completed in a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

**E. Proficiency in Mathematics**

Skill: E.22 Determine perimeters and area of geometric figures

MEASUREMENT CRITERIA

1. Determined the perimeter of various geometric figures.

2. Determined area of various geometric figures.

RESULTS:

Demonstrated ability to determine perimeter and area of geometric figures by the completion of each activity. All calculations were completed without error. Appropriate number relations, measurements, analysis and math applications were applied to each activity. All activities were completed in a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

**E. Proficiency in Mathematics**

Skill: E.23 Determine surface areas and volumes of applicable geometric figures

MEASUREMENT CRITERIA

1. Determined surface area of various geometric figures.

2. Determined volume of various geometric figures.

RESULTS:

Demonstrated ability to determine surface areas and volumes by the completion of each activity. All calculations were completed without ~~error~~ error. Appropriate number relations, measurements, analysis and math applications were applied to each activity. All activities were completed in a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

**E. Proficiency in Mathematics**

Skill: E.24 Recognize, classify and use properties of lines and angles

MEASUREMENT CRITERIA

1. Defined "positive angle".
2. Defined "negative angle".
3. Defined "Radian".
4. Defined "Arc length".
5. Described the properties of a line.
6. Converted degrees to radians.
7. Converted radians to degrees.
8. Determined size of angle from appropriate information.

RESULTS:

Demonstrated the ability to recognize, classify, and use properties of lines and angles by the completion of each activity. All calculations were completed without ~~roar.~~ Error Appropriate number relations, measurements, analysis and math applications were applied to each activity. All activities were completed in a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

**E. Proficiency in Mathematics**

Skill: E.25 Recognize, classify and use properties of two and three-dimensional figures (e.g., circles, triangles, rectangles, cylinders)

MEASUREMENT CRITERIA:

1. Defined "a circle."
2. Defined "a triangle."
3. Defined "a rectangle."
4. Defined various polygons.
5. Defined various cylinders, cubes, and other three-dimensional figures.
6. Performed various calculations related to the use of the properties of the figures.

RESULTS:

Demonstrated the ability to recognize, classify, and use properties of two and three-dimensional figures by the completion of each activity. All calculations were completed without error. Appropriate number relations, measurements, analysis and math applications were applied to each activity. All activities were completed in a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

**E. Proficiency in Mathematics**

Skill: E.26 Apply Pythagorean theorem

MEASUREMENT CRITERIA

1. Stated the "Pythagorean theorem".

2. Described and used Pythagorean Theorem to solve various geometric problems.

RESULTS:

Demonstrated knowledge and use of Pythagorean Theorem by the completion of each activity. All calculations were completed without error. Appropriate number relations, measurements, analysis and math applications were applied to each activity. All activities were completed in a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

**E. Proficiency in Mathematics**

Skill: E.27 Identify basic functions of sine, cosine, and tangent

MEASUREMENT CRITERIA

1. Defined the "six trigonometric functions".

RESULTS:

Demonstrated knowledge of basic trigonometric functions ~~of sine, cosine, and tangent~~ by the completion of each activity. All activities were completed in a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

**E. Proficiency in Mathematics**

Skill: E.28 Compute and solve problems using basic trigonometric functions

MEASUREMENT CRITERIA

1. Determined one angle given two sides of a right triangle.
2. Determined the other sides given one side and an angle.
3. Determined one angle given the other two angles.
4. Determined the tangent given the sine and cosine.
5. Determined the trigonometric fucntion of an angle given in radians.
6. Determined the trigonometric function of an angle given in degrees.
7. Determined the height of an object given the distance to the object and the angle of elevation.

RESULTS:

Demonstrated the ability to complete and solve problems using basic trigonometric functions by the completion of each activity. All calculations were completed without ~~roar~~. Appropriate number relations, measurements, analysis and math applications were applied to each activity. All activities were completed in a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

**E. Proficiency in Mathematics**

Skill: E.29 Graph basic functions using polar and/or Cartesian coordinate system

MEASUREMENT CRITERIA

1. Drew the graph of f(x,y)= 0 using a rectangular Cartesian coordinate system.

2. Drew the graph of f(x,y)= 0 using a polar coordinate system.

3. Drew the graph of the sine function.

4. Drew the graph of the cosine function.

5. Identified the shape of the graph from the equation.

RESULTS:

Demonstrated knowledge of graphing basic functions using polar and cartesian coordinates by the completion of each activity. All calculations were completed without error. Appropriate number relations, measurements, analysis and math applications were applied to each activity. All activities were completed in a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

**F. Proficiency in Physics**

Skill: F.01 Understand fundamental principles of mechanics

MEASUREMENT CRITERIA

1. Defined inertia.
2. Defined acceleration.
3. Described Newton's laws and some applications.
4. Described the forces acting upon a body.
5. Described the basic characteristics of heat transfer.

RESULTS:

Demonstrated knowledge of the fundamental principles of mechanics by the completion of each activity without error. The activities were completed within a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

**F. Proficiency in Physics**

Skill: F.02 Understand fundamental principles of pneumatics

MEASUREMENT CRITERIA

1. Described physical properties of gases.
2. Distinguished between various types of compressors, blowers and vacuum pumps.
3. Described isothermal, adiabatic and polytropic compression.
4. Solved pressure, volume and temperature problems for gases.

RESULTS:

Demonstrated knowledge of pneumatics by the completion of each activity with no errors. Accurate measurement, established safety standards and appropriate tools were used to perform each activity. The work was completed within a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

**F. Proficiency in Physics**

Skill: F.03 Understand fundamental principles of hydraulics

MEASUREMENT CRITERIA

1. Defined hydraulics and its importance.

2. Defined viscosity and its importance.

3. Defined turbulence and its importance.

4. Described the various principles of fluid motion.

RESULTS:

Demonstrated knowledge of the fundamental principles of hydraulics by the completion of each activity with no errors. All activities were completed within a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Basic and Practical Skills

**F. Proficiency in Physics**

Skill: F.04 Understand fundamental principles of electricity including its relationship to the nature of matter

MEASUREMENT CRITERIA

1. Defined electrostatic force.
2. Defined electric charge.
3. Defined impedance.
4. Defined resistance as it applies to electricity.
5. Defined electromagnetism and cited some applications.
6. Defined semi conductors and cited some applications.
7. Defined transistors and cited some applications.
8. Described the wave theory of electricity.
9. Described storage of electricity and cite some applications.
10. Described the basics of currents and why they are essential to describing the interactions among elementary particles.

RESULTS:

Demonstrated knowledge of the principles of electricity including its relationship to the nature of matter by the completion of each activity. All activities were completed within a reasonable time frame.

# TEST EQUIPMENT AND TOOLS

Occupation: General Electronics Technician

Proficiency Area: Test Equipment and Tools

Skill: TE.01 Breakout Box

MEASUREMENT CRITERIA:

1. Described the function and use of the breakout box, with examples of appropriate situations for its use.

2. Demonstrated ability to use a breakout box.

3. Applied all necessary safety procedures.

4. Demonstrated correct set-up procedures.

RESULTS:

Demonstrated knowledge of the appropriate and correct use of a breakout box using necessary safety procedures within a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Test Equipment and Tools

Skill: TE.02 Calibration Standards

MEASUREMENT CRITERIA:

1. Be aware of the existence of calibration ~~standards~~ requirements for test equipment and tools.

RESULTS:

Demonstrated knowledge of the appropriate and correct use of calibration ~~standards using necessary safety procedures within a reasonable time frame.~~ requirements.

Occupation: General Electronics Technician

Proficiency Area: Test Equipment and Tools

Skill: TE.03 Capacitor/Inductor Analyzer

MEASUREMENT CRITERIA:

1. Described the function and use of the capacitor/inductor analyzer, with examples of appropriate situations for its use.

2. Demonstrated ability to use a capacitor/inductor analyzer.

3. Applied all necessary safety procedures.

4. Demonstrated correct set-up procedures.

5. Recorded results of equipment use.

6. Interpreted results of testing.

RESULTS:

Demonstrated knowledge of the appropriate and correct use of a capacitor/inductor analyzer using necessary safety procedures within a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Test Equipment and Tools

Skill: TE.04 Current Probe

MEASUREMENT CRITERIA:

1. Described the function and use of the current probe, with examples of appropriate situations for its use.

2. Demonstrated ability to use a current probe.

3. Applied all necessary safety procedures.

4. Demonstrated correct set-up procedures.

5. Recorded results of equipment use.

6. Interpreted results of testing.

RESULTS:

Demonstrated knowledge of the appropriate and correct use of a current probe using necessary safety procedures within a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Test Equipment and Tools

Skill: TE.05 DC Power Source

MEASUREMENT CRITERIA:

1. Described the function and use of the DC power source, with examples of appropriate situations for its use.

2. Demonstrated ability to use a DC power source.

3. Applied all necessary safety procedures.

4. Demonstrated correct set-up procedures.

+5

RESULTS:

+4

Demonstrated knowledge of the appropriate and correct use of a DC power source using necessary safety procedures within a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Test Equipment and Tools

Skill: TE.06 Digital Storage Oscilloscope

MEASUREMENT CRITERIA:

1. Described the function and use of the digital storage oscilloscope, with examples of appropriate situations for its use.

2. Demonstrated ability to use a digital storage oscilloscope.

3. Applied all necessary safety procedures.

4. Demonstrated correct set-up procedures.

5. Recorded results of equipment use.

6. Interpreted results of testing.

RESULTS:

Demonstrated knowledge of the appropriate and correct use of a digital storage oscilloscope using necessary safety procedures within a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Test Equipment and Tools

Skill: TE.07 Dummy Load

MEASUREMENT CRITERIA:

1. Described the function and use of the dummy load, with examples of appropriate situations for its use.

2. Demonstrated ability to use a dummy load.

3. Applied all necessary safety procedures.

4. Demonstrated correct set-up procedures.

RESULTS:

Demonstrated knowledge of the appropriate and correct use of a dummy load using necessary safety procedures within a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Test Equipment and Tools

Skill: TE.08 Electrical Field Strength Meter

MEASUREMENT CRITERIA:

1. Described the function and use of the electrical field strength meter, with examples of appropriate situations for its use.

2. Demonstrated ability to use an electrical field strength meter.

3. Applied all necessary safety procedures.

4. Demonstrated correct set-up procedures.

5. Recorded results of equipment use.

6. Interpreted results of testing.

RESULTS:

Demonstrated knowledge of the appropriate and correct use of an electrical field strength meter using necessary safety procedures within a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Test Equipment and Tools

Skill: TE.09 Electrical Resistance Insulation Tester

MEASUREMENT CRITERIA:

1. Described the function and use of an electrical resistance insulation tester, with examples of appropriate situations for its use.

2. Demonstrated ability to use an electrical resistance insulation tester.

3. Applied all necessary safety procedures.

4. Demonstrated correct set-up procedures.

5. Recorded results of equipment use.

6. Interpreted results of testing.

RESULTS:

Demonstrated knowledge of the appropriate and correct use of an electrical resistance insulation tester using necessary safety procedures within a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Test Equipment and Tools

Skill: TE.10 Electrostatic Discharge Meter (ESD)

MEASUREMENT CRITERIA:

1. Described the function and use of an electrostatic discharge meter (ESD), with examples of appropriate situations for its use.

2. Applied all necessary safety procedures.

RESULTS:

Demonstrated knowledge of the appropriate and correct use of an electrostatic discharge meter (ESD) using necessary safety procedures within a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Test Equipment and Tools

Skill: TE.11 Frequency Counter

MEASUREMENT CRITERIA:

1. Described the function and use of the frequency counter, with examples of appropriate situations for its use.

2. Demonstrated ability to use a frequency counter.

3. Applied all necessary safety procedures.

4. Demonstrated correct set-up procedures.

5. Recorded results of equipment use.

6. Interpreted results of testing.

RESULTS:

Demonstrated knowledge of the appropriate and correct use of a frequency counter using necessary safety procedures within a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Test Equipment and Tools

Skill: TE.12 Function Generator

MEASUREMENT CRITERIA:

1. Described the function and use of the function generator, with examples of appropriate situations for its use.

2. Demonstrated ability to use a function generator.

3. Applied all necessary safety procedures.

4. Demonstrated correct set-up procedures.

5. Recorded results of equipment use.

6. Interpreted results of testing.

RESULTS:

Demonstrated knowledge of the appropriate and correct use of a function generator using necessary safety procedures within a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Test Equipment and Tools

Skill: TE.13 Ground Fault Testers

MEASUREMENT CRITERIA:

1. Described the function and use of the ground fault tester, with examples of appropriate situations for its use.

2. Applied all necessary safety procedures.

RESULTS:

Demonstrated knowledge of the appropriate and correct use of a ground fault tester using necessary safety procedures within a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Test Equipment and Tools

Skill: TE.14 Hand Tools

MEASUREMENT CRITERIA:

1. Described the function and use of hand tools, with examples of appropriate situations for its use.

2. Demonstrated ability to use hand tools.

3. Applied all necessary safety procedures.

4. Demonstrated correct set-up procedures.

RESULTS:

Demonstrated knowledge of the appropriate and correct use of hand tools using necessary safety procedures within a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Test Equipment and Tools

Skill: TE.15 High Potential Testers

MEASUREMENT CRITERIA:

1. Described the function and use of the high potential tester, with examples of appropriate situations for its use.

2. Applied all necessary safety procedures.

RESULTS:

Demonstrated knowledge of the appropriate and correct use of a high potential tester using necessary safety procedures within a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Test Equipment and Tools

Skill: TE.16 Isolation Transformer

MEASUREMENT CRITERIA:

1. Described the function and use of the isolation transformer, with examples of appropriate situations for its use.

2. Demonstrated ability to use an isolation transformer.

3. Applied all necessary safety procedures.

4. Demonstrated correct set-up procedures.

RESULTS:

Demonstrated knowledge of the appropriate and correct use of an isolation transformer using necessary safety procedures within a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Test Equipment and Tools

Skill: TE.17 LASER Power Meter

MEASUREMENT CRITERIA:

1. Described the function and use of the LASER power meter, with examples of appropriate situations for its use.

2. Applied all necessary safety procedures.

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4
5
6

RESULTS:

Demonstrated knowledge of the appropriate and correct use of a LASER power meter using necessary safety procedures within a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Test Equipment and Tools

Skill: TE.18 Light Intensity Meter

MEASUREMENT CRITERIA:

1. Described the function and use of the light intensity meter, with examples of appropriate situations for its use.

2. Applied all necessary safety procedures.

RESULTS:

Demonstrated knowledge of the appropriate and correct use of a light intensity meter using necessary safety procedures within a reasonable time frame.

3
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Occupation: General Electronics Technician

Proficiency Area: Test Equipment and Tools

Skill: TE.19 Logic Analyzer

MEASUREMENT CRITERIA:

1. Described the function and use of the logic analyzer, with examples of appropriate situations for its use.
2. Demonstrated ability to use a logic analyzer.
3. Applied all necessary safety procedures.
4. Demonstrated correct set-up procedures.
5. Recorded results of equipment use.
6. Interpreted results of testing.

RESULTS:

Demonstrated knowledge of the appropriate and correct use of a logic analyzer using necessary safety procedures within a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Test Equipment and Tools

Skill: TE.20 Logic Probe

MEASUREMENT CRITERIA:

1. Described the function and use of the logic probe, with examples of appropriate situations for its use.

2. Demonstrated ability to use a logic probe.

3. Applied all necessary safety procedures.

4. Demonstrated correct set-up procedures.

5. Recorded results of equipment use.

6. Interpreted results of testing.

RESULTS:

Demonstrated knowledge of the appropriate and correct use of a logic probe using necessary safety procedures within a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Test Equipment and Tools

Skill: TE.21 Logic Pulser

MEASUREMENT CRITERIA:

1. Described the function and use of the logic pulser, with examples of appropriate situations for its use.
2. Demonstrated ability to use a logic pulser.
3. Applied all necessary safety procedures.
4. Demonstrated correct set-up procedures.
5. Recorded results of equipment use.
6. Interpreted results of testing.

RESULTS:

Demonstrated knowledge of the appropriate and correct use of a logic pulser using necessary safety procedures within a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Test Equipment and Tools

Skill: TE.22 Multimeters (Digital and Analog)

MEASUREMENT CRITERIA:

1. Described the function and use of the multimeter (digital and analog), with examples of appropriate situations for its use.

2. Demonstrated ability to use a multimeter (digital and analog).

3. Applied all necessary safety procedures.

4. Demonstrated correct set-up procedures.

5. Recorded results of equipment use.

6. Interpreted results of testing.

RESULTS:

Demonstrated knowledge of the appropriate and correct use of a multimeter (digital and analog) using necessary safety procedures within a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Test Equipment and Tools

Skill: TE.23 Oscilloscope

MEASUREMENT CRITERIA:

1. Described the function and use of the oscilloscope, with examples of appropriate situations for its use.
2. Demonstrated ability to use an oscilloscope.
3. Applied all necessary safety procedures.
4. Demonstrated correct set-up procedures.
5. Recorded results of equipment use.
6. Interpreted results of testing.

RESULTS:

Demonstrated knowledge of the appropriate and correct use of an oscilloscope using necessary safety procedures within a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Test Equipment and Tools

Skill: TE.24 Power Tools

MEASUREMENT CRITERIA:

1. Described the function and use of power tools, with examples of appropriate situations for its use.

2. Demonstrated ability to use power tools.

3. Applied all necessary safety procedures.

4. Demonstrated correct set-up procedures.

RESULTS:

Demonstrated knowledge of the appropriate and correct use of power tools using necessary safety procedures within a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Test Equipment and Tools

Skill: TE.25 Pressure Gauges

MEASUREMENT CRITERIA:

1. Described the function and use of pressure gauges, with examples of appropriate situations for its use.

2. Applied all necessary safety procedures.

3
4
5
6

RESULTS:

Demonstrated knowledge of the appropriate and correct use of pressure gauges using necessary safety procedures within a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Test Equipment and Tools

Skill: TE.26 RF Power Meter

MEASUREMENT CRITERIA:

1. Described the function and use of the RF power meter, with examples of appropriate situations for its use.

2. Demonstrated ability to use an RF power meter.

3. Applied all necessary safety procedures.

4. Demonstrated correct set-up procedures.

5. Recorded results of equipment use.

6. Interpreted results of testing.

RESULTS:

Demonstrated knowledge of the appropriate and correct use of an RF power meter using necessary safety procedures within a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Test Equipment and Tools

Skill: TE.27 RF Signal Generator

MEASUREMENT CRITERIA:

1. Described the function and use of the RF signal generator, with examples of appropriate situations for its use.

2. Demonstrated ability to use an RF signal generator.

3. Applied all necessary safety procedures.

4. Demonstrated correct set-up procedures.

5. Recorded results of equipment use.

6. Interpreted results of testing.

RESULTS:

Demonstrated knowledge of the appropriate and correct use of an RF signal generator using necessary safety procedures within a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Test Equipment and Tools

Skill: TE.28 Semiconductor Tester

MEASUREMENT CRITERIA:

1. Described the function and use of a semiconductor tester, with examples of appropriate situations for its use.

2. Applied all necessary safety procedures.

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RESULTS:

Demonstrated knowledge of the appropriate and correct use of a semiconductor tester using necessary safety procedures within a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Test Equipment and Tools

Skill: TE.29 Soldering/Desoldering Equipment and Supplies

MEASUREMENT CRITERIA:

1. Described the function and use of soldering/desoldering equipment and supplies, with examples of appropriate situations for its use.

2. Demonstrated ability to use soldering/desoldering equipment and supplies.

3. Applied all necessary safety procedures.

4. Demonstrated correct set-up procedures.

RESULTS:

Demonstrated knowledge of the appropriate and correct use of soldering/desoldering equipment and supplies using necessary safety procedures within a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Test Equipment and Tools

Skill: TE.30 Soldering/Desoldering Equipment and Supplies for Surface Mount Devices (SMD)

MEASUREMENT CRITERIA:

1. Described the function and use of soldering/desoldering equipment and supplies for surface mount devices (SMD), with examples of appropriate situations for its use.

2. Demonstrated ability to use soldering/desoldering equipment and supplies for surface mount devices (SMD).

3. Applied all necessary safety procedures.

4. Demonstrated correct set-up procedures.

5
6

RESULTS:

Demonstrated knowledge of the appropriate and correct use of soldering/desoldering equipment and supplies for surface mount devices (SMD) using necessary safety procedures within a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Test Equipment and Tools

Skill: TE.31 Spectrum Analyzer

MEASUREMENT CRITERIA:

1. Described the function and use of the spectrum analyzer, with examples of appropriate situations for its use.

2. Demonstrated ability to use a spectrum analyzer.

3. Applied all necessary safety procedures.

4. Demonstrated correct set-up procedures.

5. Recorded results of equipment use.

6. Interpreted results of testing.

RESULTS:

Demonstrated knowledge of the appropriate and correct use of a spectrum analyzer using necessary safety procedures within a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Test Equipment and Tools

Skill: TE.32 Temperature Transducer

MEASUREMENT CRITERIA:

1. Described the function and use of the temperature transducer, with examples of appropriate situations for its use.

2. Applied all necessary safety procedures.

3
4
5
6

RESULTS:

Demonstrated knowledge of the appropriate and correct use of a temperature transducer using necessary safety procedures within a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Test Equipment and Tools

Skill: TE.33 Torque Measuring Tools

MEASUREMENT CRITERIA:

1. Be aware of the existence of torque measuring tools.

RESULTS:

Demonstrated knowledge of the appropriate and correct use of torque measuring tools using necessary safety procedures within a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Test Equipment and Tools

Skill: TE.34 Vacuum Gauges

MEASUREMENT CRITERIA:

1. Described the function and use of vacuum gauges, with examples of appropriate situations for its use.

2. Applied all necessary safety procedures.

3
4
5
6

RESULTS:

Demonstrated knowledge of the appropriate and correct use of vacuum gauges using necessary safety procedures within a reasonable time frame.

Occupation: General Electronics Technician

Proficiency Area: Test Equipment and Tools

Skill: TE.35 Voltage Isolation Transformer (Adjustable)

MEASUREMENT CRITERIA:

1. Described the function and use of the voltage isolation transformer (adjustable), with examples of appropriate situations for its use.

2. Demonstrated ability to use a voltage isolation transformer (adjustable).

3. Applied all necessary safety procedures.

4. Demonstrated correct set-up procedures.

RESULTS:

Demonstrated knowledge of the appropriate and correct use of a voltage isolation transformer (adjustable) using necessary safety procedures within a reasonable time frame.

# AMERICAN NATIONAL STANDARD

*Quality Management and Quality Assurance Standards - Guidelines for the Application of ANSI/ASQC Q9001-1994 or Q9002-1994 to Education and Training Institutions*

AMERICAN SOCIETY FOR QUALITY CONTROL
611 EAST WISCONSIN AVENUE
MILWAUKEE, WISCONSIN 53202

# Foreword

Z-1.11 is the product of a working group under the joint American National Standards Institute (ANSI) and the American Society for Quality Control (ASQC) Accredited Standards Committee Z-1 on Quality Assurance, consisting of the following members:

Frank Caplan, President, Quality Sciences Consultants, and Executive Secretary, National Educational Quality Initiative; Editor-in-Chief, *Quality Engineering*

Walter Dick, Professor of Instructional Systems, The Florida State University

Wellesley Foshay, Vice-President Quality Assurance, Standards, and Training, TRO Learning, Inc.

William A. J. Golomski, Quality Consultant, and Vice-President of Membership and Education, International Academy for Quality; Editor, *Quality Management*

Donald W. Marquardt, Consultant on Quality, Management, and Statistics, and Chair, International Organization for Standardization (ISO), Technical Committee 176 Quality Management and Quality Assurance

F. Craig Johnson, Professor of Educational Research, Florida State University, Chair, ASQC Education Division Standards Committee, and U.S. Lead Expert to ISO TC 176 Work Group on Continuing Education and Training, and Chair, Z-1.11 working group.

Charles Melvin, III, Superintendent, Beloit-Turner School District

Robert Peach, Quality Consultant, and Chair, ASQC Standards Council; Chair, Registrar Accreditation Board; Convener, Working Group on development and updating ISO 9004-1 on quality management and quality system elements

Joe Tsiakals, Vice-President, Quality Management Baxter International; and Chair, ANSI Z-1 Committee; Convener, working group on the development and updating ISO 9001-1-3.

Ray Wachniak, Corporate Quality Director, (Retired), Bridgestone/Firestone

Harrison Wadsworth, Quality Consultant, Chair, ASQC Standards Committee, and Chair, ISO Technical Committee 69 Vocabulary Subcommittee

The validation of this guideline consisted of a development and review process conducted by authorities in the design of instruction, the application of quality design principles to education and training institutions, and experienced quality professionals. Drafts of Z-1.11 were reviewed by members of the American Association of School Administrators, American Society for Training and Development, National Society for Performance and Instruction, National Education Association, American Federation of Teachers, and by all members of ANSI Z-1 and ISO TC 176. The working group gratefully acknowledges their many thoughtful contributions.

Z-1.11 combines two systems, begun in the early decades of the twentieth century, which have developed since the second World War. The first, the instructional system, has been used to design, develop, deliver, and assess instruction in military, industrial, service, education and training institutions. The second, the quality system, has been used to ensure quality in many of these same institutions. Using a quality system to ensure quality instruction in education and training institutions is a relatively recent development in the United States. In the United Kingdom, however, over one hundred schools and colleges have registered their instructional quality system to ISO 9002 (the international equivalent of the U.S. ANSI/ASQC Q9002). The British Standards Institute's quality audit guidelines, used for registration in the United Kingdom, continue as an integral part of Z-1.11.

Z-1.11, in its role as a guidance standard, focuses on the generic quality system requirements of Q9001 or Q9002 and on their application to education and training institutions. Like some service industries, education and training institutions provide a mental product that is intangible, not storable, and consumed during delivery. Education and training institutions provide the opportunity for students to study existing knowledge and to practice its application. These institutions also have administrative support systems which help to ensure quality instruction. Students, one way or another, pay for instruction. As customers, their needs and expectations for improved mental or physical ability should be met and surpassed. The relationship between instructors and students differs from the relationship between industrial workers and their customers in that students perform as workers and become part of the product to which value is added. Instructors typically, but not always, work directly with students as they perform mental or physical tasks.

Z-1.11 was not prepared as a synthesis of the best quality system practices applied to education and training institutions, since these applications are in a formative stage in the United States. The guidance provides suggestions to suppliers of education and training who elect to register their quality system to a quality assurance standard. The development of the quality system should follow the suggestions provided in ANSI/ASQC 9004-1-1994, Quality Management and Quality Systems Elements - guidelines.

While it is appropriate for Z-1.11 to suggest specific guidelines, this does not mean that Q9004-1 nor Z-1.11 are the only way to meet the requirements of Q9001 or Q9002. There are other approaches to education and training, some of which appear in the Bibliography, which may be equally effective. It should not be implied that suggestions made in Q9004-1 or Z-1.11 are requirements.

If the Working Group has met its objectives, then those experienced in systems approaches will find the language and logic familiar; experienced quality professionals will find the rigor of quality practice intact; and experienced educators and trainers will find suggestions on implementing quality systems relevant to their current practice.

Z-1.11 was designed to be user-friendly. First, the entire text of ANSI/ASQC Z-1.11 has been reprinted in the right-hand column. ANSI/ASQC Q9001 is produced in the left-hand column. This shows the relationship between the two allows the user to validate their correspondence.

Second, some sections in Z-1.11 have additional parenthetical titles to match terms commonly used in education and training. Some paragraphs of Q9001 have not been addressed in Z-1.11 either because the paragraph of Q9001 can be directly applied or because there is little relevance for education and training institutions. In several cases, new sub-paragraphs have been added, but not numbered, to address special conditions found in education and training institutions.

Finally, some background and philosophy has been included from ANSI/ASQC Q9000 Quality Management and Quality Assurance Standards - Guideline for Selection and Use. Selected key points from Q9000 are paraphrased below for application of Q9001 to education and training. The reader is encouraged to consult Q9000 for the complete text.

1. A curriculum specifies what students are expected to learn and how their learning is to be assessed. However, the curriculum by itself does not guarantee that students' needs and expectations will be met if deficient administrative practices exist in the education or training institutions. The need to prevent these deficiencies has led to the application of quality standards and associated guidelines when implementing a quality system within education and training institutions.

2. Each quality system is influenced by different educational and training objectives, by different instructional methods, and by different administrative practices specific to the institution. Therefore, quality systems can be expected to vary from one institution to another, but should be based on the same principles.

3. The quality system should be the simplest one that works well. It need be only comprehensive enough to meet the quality objectives for the education or training institution.

4. Quality control is an essential element in a quality system. Precision measurement is elusive when assessing human performance and appraisal is usually conducted while the student is learning. Control is aimed at monitoring administrative and instructional processes to prevent root causes of deficient administrative practice or unsatisfactory student performance. Establishing the stability and capability of these processes may be necessary prior to improving them.

5. Quality assurance requires a continuing evaluation of the curriculum and the administrative practices which suppon instruction to ensure the effectiveness of the learning process Internal quality audits provide verification of stated claims which, in turn, provide confidence. Providing effectiveness may require documentation which may reside in quality manuals or in computers. In addition to doing things the right way, education and training institutions should be doing the right things for their customers.

# Contents

ANSI/ASQC Q9001-1994

## 1 SCOPE

This American National Standard specifies quality-system requirements for use where a supplier's capability to design and supply conforming product needs to be demonstrated.

The requirements specified are aimed primarily at achieving customer satisfaction by preventing nonconformity at all states from design through to servicing.

This American National Standard is applicable in situations when

ANSI/ASQC Z-1.11 — GUIDELINES FOR THE APPLICATION OF ANSI/ASQC Q9001 or Q9002 TO EDUCATION AND TRAINING INSTITUTIONS

The guidelines provided in Z-1.11 serve two related purposes. First, to provide education and training institutions with the benefits of nationally accepted guideline standards of quality assurance and quality management practices contained in the American National Standards Institute and the American Society for Quality Control Q9000 series. The second purpose is to improve the communication between education or training institutions and their registrars as they prepare to register to Q9001 or Q9002. Both purposes can best be served when institutions, as a first step, align their quality practices with the Guidelines provided in *Quality Management and Quality System Elements – Guidelines (Q9004-1)*. Z-1.11 adds to this guidance some notes, explanations, terminology, and additional generic and descriptive language which has been validated by the experience of quality, education, and training professionals.

Z-1.11 does not change, replace, amend, nor supersede the requirements of Q9001 or Q9002.

Z-1.11 is not written as a stand-alone document for use in contacts. However, those choosing to include Z-1.11 in contracts need to be aware that Z-1.11 has not been validated as best practice nor is there strong evidence that alternative ways of achieving the same results are necessarily inferior.

## 1 SCOPE

Z-1.11 has been prepared to guide education and training institutions when using either ASQC/ANSI Q9001 or Q9002. Institutions which do not design their own curricula may select Q9002 and disregard Quality Element 4.4 Design Control. Q9003 is considered inappropriate since Z-1.11 focuses on institutions while Q9003 focuses on vendors of packaged instruction. All education and training institutions should benefit from the guidance provided in Q9004-1. Since the paragraph numbers for Q9001, Q9002, and Q9004-1 do not match, some adjustments will be needed.

a) design is required and the product requirements are stated principally in performance terms, or they need to be established, and
b) confidence in product conformance can be attained by adequate demonstration of a supplier's capabilities in design, development, production, installation, and servicing.

NOTE 1 For information references, see annex A.

## 2 NORMATIVE REFERENCE

The following standard contains provisions which, through reference in this text, constitute provisions of this American National Standard. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this American National Standard are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below. The American National Standards Institute and members of IEC and ISO maintain registers of currently valid American National Standards and International Standards.

ISO 8402:1994, *Quality management and quality assurance—Vocabulary.*

## 3 DEFINITIONS

For purposes of this American National Standard, the definitions given in ISO 8402 and the following definitions apply.

**3.1 product:** Result of activities or processes.

NOTES

2. A product may include service, hardware, processed materials, software, or a combination

Z-1.11 covers instructional design, development, instruction delivery, assessment of students, and support services. Education and training institutions may use Z-1.11 in the following situations:

a) registration to Q9001 or Q9002 and for the use of Q9001 or Q9002 in contracts which require, in addition to the instruction requested, provisions for instructional materials books, supplies, equipment, laboratory devices, and working models; and
b) a request by an education or training organization for a third party quality assessment of its instructional system.

**Note.** The voluntary regional accreditation of educational institutions frequently use third party assessments.

## 2 NORMATIVE REFERENCE

*ANSI/ASQC A8402:1994, Quality management and quality assurance - vocabulary*

*ANSI/ASQC Q9004-1-1994, Quality management and quality systems elements – guidelines*

## 3 DEFINITIONS

For the purpose of Z-1.11 the following definitions apply.

**Customers** – ANSI/ASQC A8402 defines the customer as the recipient of a product provided by the supplier. ANSI/ASQC Q9004-1-1994 also defines the term "stakeholder" which is frequently used in education and training where it includes, among others, the following:

thereof.

3. A product can be tangible (e.g., assemblies or processed materials) or intangible (e.g., knowledge or concepts), or a combination thereof.

4. For the purposes of this American National Standard, the term "product" applies to the intended product offering only and not to unintended "by-products" affecting the environment. This differs from the definition given is ISO 8402.

**3.2 tender:** Offer made by a supplier in response to an invitation to satisfy a contract awarded to provide product.

**3.3 contract; accepted order:** Agreed requirements between a supplier and customer transmitted by any means.

a) students who receive instruction through public or private instruction organizations;

b) companies whose employees receive instruction either from internal training departments or from external training suppliers;

c) communities which elect school boards to hire teachers, staff, and administrators who operate as their representative for the students' benefit; and

d) society in general.

Note. The relationship between stakeholders differs somewhat from those common among customers, suppliers, and producers. A noteworthy difference among stakeholders is the lack of exclusion in education. Use of education does not preclude the use by others whereas eating an apple would.

**Instruction** – the process of planning and providing the time, order, place, materials, and guidance required for students to meet the instructional specification. While there are philosophical and practical differences between training and education, they do not impact the quality system and are not differentiated in Z-1.11. "Instruction" is used to cover both education and training.

**The Instruction Product** – enhanced knowledge, increased ability, or improved skill which can be assessed and then certified by credit, certificate, degree, or diploma. ANSI/ASQC A8402 notes information or concepts as products.

**Instruction Supplier** – the organization, (school, college, university, or commercial unit) responsible for instruction and the employer of administrators, support staff, and instructors to supply instruction.

**Instructor** – provider of instruction (teacher, trainer, course designer, educational material developer, consultant, and training department personnel). Instructors typically are under contract with, or employees of, an instruction supplier.

**Instruction Specification** – written information, made available to students about a program or course, should include but not be limited to the following:

a) title of program or course;
b) credit, diploma, degree, or certificate;
c) time required;

d) intended outcomes/training goals;
e) student entry skill and knowledge;
f) performance objectives and standards;
g) major concepts and content;
h) classroom, laboratory, or shop activities;
i) measures of student competence, e.g., written examinations or instructor observations.

**Entry Level Skills** - skills and knowledge the students have acquired prior to the instruction in order to complete instruction successfully.

**Target Population** - students for whom the instruction is intended.

**Formative Evaluation** - conducted during the formative stages of its design, development, and delivery to improve the instruction.

**Summative Evaluation** - conducted just after the instruction to summarize data for an evaluative decision about students (grades) or the instruction (revisions).

**Impact Evaluation** - conducted after sufficient time has passed to determine that the student retains and/or applies effectively the knowledge and skills learned.

## 4 QUALITY-SYSTEM REQUIREMENTS

## 4 QUALITY SYSTEM REQUIREMENTS

### 4.1 MANAGEMENT RESPONSIBILITY

### 4.1 MANAGEMENT RESPONSIBILITY
(Administrations' Responsibility)

#### 4.1.1 Quality Policy

The supplier's management with executive responsibility shall define and document its policy for quality, including objectives for quality and its commitment to quality. The quality policy shall be relevant to the supplier's organizational goals and the expectations and needs of its customers. The supplier shall ensure that this policy is understood, implemented, and maintained at all levels of the organization.

#### 4.1.1 Quality Policy

The quality policy should be consistent with other company, organization, professional, or governmental policies. All employees working for an instruction supplier affect the quality of instruction. Management should ensure that the quality policy is understood, implemented, and maintained by all full and part-time instructors, support staff, and subcontractors.

#### 4.1.2 Organization

#### 4.1.2 Organization (School or Training Company)

##### 4.1.2.1 Responsibility and authority

The responsibility, authority, and the interrelation of personnel who manage, perform, and verify work

##### 4.1.2.1 Responsibility and authority

The personnel who manage, perform, and verify work affecting the quality of instruction should be free to

affecting quality shall be defined and documented, particularly for personnel who need the organizational freedom and authority to:

a) initiate action to prevent the occurrence of any non-conformities relating to product, process, and quality system;

b) identify and record any problems relating to the product, process, and quality system;

c) initiate, recommend, or provide solutions through designated channels;

d) verify the implementation of solutions;

e) control further processing, delivery, or installation of nonconforming product until the deficiency or unsatisfactory condition has been corrected.

#### 4.1.2.2 Resources

The supplier shall identify resource requirements and provide adequate resources, including the assignment of trained personnel (see 4.18), for management, performance of work, and verification activities including internal quality audits.

#### 4.1.2.3 Management representative

The supplier's management with executive responsibility shall appoint a member of the supplier's own management who, irrespective or other responsibilities, shall have defined authority for

a) ensuring that a quality system is established, implemented, and maintained in accordance with this American National Standard, and

b) reporting on the performance of the quality system to the supplier's management for review and as a basis for improvement of the quality system.

Note 5 The responsibility of a management representative may also include liaison with external parties on matters relating to the supplier's quality system.

identify, record, and solve problems where instructional systems have not met the instructional specification or students have not accomplished the assigned tasks.

#### 4.1.2.2 Resources

Verification activities should be used to monitor on-going instruction. Administrators, staff, instructors, and those who support instruction should be given the training and authority to provide or support instruction. There should be procedures to cover assessment, testing, review, and monitoring activities whether performed by or for the instructor, an instructor aide, or the student.

#### 4.1.2.3 Management representative

The instruction supplier should give one person the responsibility for ensuring that the requirements of Q9001 or Q9002 are met on an on-going basis or that the guidance provided in Z-1.11 is being faithfully implemented. This person should know the contents of these standards and be available for advice on their implementation.

4.1.3 Management review

The supplier's management with executive responsibility shall review the quality system at defined intervals sufficient to ensure its continuing suitability and effectiveness in satisfying the requirements of this American National Standard and the supplier's stated quality policy and objectives (see 4.1.1). Records of such reviews shall be maintained (see 4.16)

4.1.3 Management Review

Since this is the top level review of the quality system, it should include the scheduled periodic review of the instructional and support systems, customer satisfaction, assessment criteria, evaluation results, and documented improvements. This list is neither exhaustive nor prescriptive. Records of these reviews should be kept.

4.2 QUALITY SYSTEM

4.2.1 General

The supplier shall establish, document, and maintain a quality system as a means of ensuring that product conforms to specified requirements. The supplier shall prepare a quality manual covering the requirements of this American National Standard. The quality manual shall include or make reference to the quality-system procedures and outline the structure of the documentation used in the quality system.

Note 6 Guidance on quality manuals is given in ISO 10013.

4.2.2 Quality-system procedures

The supplier shall

a) prepare documented procedures consistent with the requirements of this American National Standard and the supplier's stated quality policy, and

b) effectively implement the quality system and its documented procedures.

For the purposes of this American National Standard, the range and detail of the procedures that form part of the quality system depend on the complexity of the work, the methods used, and the skills and training needed by personnel involved in carrying out the activity.

NOTE 7 Documented procedures may make reference to work instructions that define how an activity is performed.

4.2 QUALITY SYSTEM

An education or training quality system should be understood to be the organizational structure, responsibilities, procedures, and resources which ensure the quality of instruction. This includes most activities of the instruction suppliers' employees or subcontractors. Processes should be found in quality manuals. Control of instruction may be exercised during the following processes:

a) instructional needs assessment;
b) instructional design;
c) instructional development;
d) delivery of instruction;
e) operation of libraries, workshops, and laboratories; and
f) evaluation.

4.2.3 Quality planning

The supplier shall define and document how the requirements for quality will be met. Quality planning shall be consistent with all other requirements of a supplier's quality system and shall be documented in a format to suit the supplier's method of operation. The supplier shall give consideration to the following activities, as appropriate, in meeting the specified requirements for products, projects, or contracts:

a) the preparation of quality plans;

b) the identification and acquisition of any controls, processes, equipment (including inspection and test equipment), fixtures, resources, and skills that may be needed to achieve the required quality;

d) the updating, as necessary, of quality control, inspection, and testing techniques, including the development of new instrumentation;

e) the identification of any measurement requirement involving capability that exceeds the known state of the art, in sufficient time for the needed capability to be developed;

f) the identification of suitable verification at appropriate stages in the realization of product;

g) the clarification of standards of acceptability for all features and requirements, including those which contain a subjective element;

h) the identification and preparation of quality records (see 4.16).

NOTE 8 The quality plans referred to (see 4.2.3a) may be in the form of a reference to the appropriate documented procedures that form an integral part of the supplier's quality system.

4.2.3 Quality planning

Adequately covered by Q9001-1994.

4.3 CONTRACT REVIEW

4.3.1 General

The supplier shall establish and maintain documented procedures for contract review and for the coordination of these activities.

4.3 CONTRACT REVIEW

There should be a documented procedure for contract review covering all activities at the student and instruction supplier interface. These might range from an individual student enrollment to contracts for producing whole programs of study for many

### 4.3.2 Review

Before submission of a tender, or at the acceptance of a contract or order (statement of requirement), the tender, contract or order shall be reviewed by the supplier to ensure that:

a) the requirements are adequately defined and documented; where no written statement of requirement is available for an order received by verbal means, the supplier shall ensure that the order requirements are agreed before their acceptance;

b) any differences between the contract or accepted order requirements and those in the tender are resolved;

c) the supplier has the capability to meet the contract or accepted order requirements.

### 4.3.3 Amendment to contract

The supplier shall identify how an amendment to a contract is made and correctly transferred to the functions concerned within the supplier's organization.

### 4.3.4 Records

Records of contract reviews shall be maintained (see 4.16).

NOTE 9 Channels for communication and interfaces with the customer's organization in these contract matters should be established.

## 4.4 DESIGN CONTROL

institutions. Instruction suppliers should record what instruction is being offered, what is selected by students, and what credit, diploma, degree or certificate can be awarded. A contract may be actual or implied (often the case in training departments), written or oral. Contracts should be reviewed at the proposal stage and, at a minimum, annually thereafter to assure that all requirements are met. Differences from proposals should be resolved. Evidence should exist where customer and supplier have mutually agreed to contract changes.

## 4.4 DESIGN CONTROL

A design control activities should apply to the type and duration of the training. When applied to education and training this requirement is typically addressed by the evaluation criteria used by accrediting bodies to assure consistent evaluation of a credit, diploma, degree, or certificate earned at or from instruction suppliers.

A second application relates to procedures necessary to ensure that common texts and software should be available and match the instruction requirements.

A third application relates to the measurement instruments used in instruction.

Note. While calibration is critical for some laboratory sciences, it may not need to be exact for an instructional purpose.

### 4.4.1 General

The supplier shall establish and maintain documented procedures to control and verify the design of the product in order to ensure that the specified requirements are met.

### 4.4.1 General

Adequately covered by Q9001-1994.

**Needs Assessment**

Before the supplier can ensure that the Instruction specifications can be met, market research in some form of a needs assessment should be performed. Needs assessment can be accomplished in a variety of formats and by any combination of customer and supplier. The following paragraphs and Figure 1 outline acceptable practice in education and training and meet the design requirements of Q9001.

**Needs Assessment, Report of Results, and Review**

Figure 1 presents a flow chart of the major activities associated with the implementation of a quality system for instruction. The flow of support processes should also be described by instruction suppliers.

**Conduct Needs Assessment and Analysis**

(Sometimes referred to as "performance systems analysis" or "needs analysis.")

A needs assessment should be conducted to identify potential or actual performance needs created at least in part by the absence of or inadequate instruction, to determine:

a) how instruction can provide skills that help to meet needs;

b) how future opportunities can be identified and how needs can be met;

c) specific measures to determine instruction effectiveness; and

d) if skills taught match initially identified needs. (This type of summative evaluation is referred to as Level 3 and 4 evaluation in literature on training). These studies provide information

which can be used in the instruction review process.

**Prepare Report of Needs Assessment and Analysis**

A needs assessment results report should provide input to the instructional design process based upon information from the needs assessment process. The report should summarize results of the needs assessment and state the goals for instruction in terms of student performance standards, general characteristics of the target population, and any special process information relevant to the design.

**Review and Revise Needs Assessment and Analysis Report**

The results from the needs assessment and analysis report should be reviewed. The review procedures should be stated along with the names or titles of individuals responsible for the review. Typically a report should:

a) state the performance needs which the instruction was designed to meet;

b) identify all customers and target populations of students;

c) state how the needs are to be met in performance terms and state the rationale;

d) identify potential quality failures which the instruction will prevent;

e) specify any changes which should be made by the customer before effective instruction can be assured; and

f) state that all relevant safety and legislative regulations will be observed even when unstated in the contract, instruction specification, or curriculum.

**Revision of Needs Assessment and Analysis Process**

A review of the needs assessment and analysis process should be conducted by the instruction supplier in consultation with the customer to identify any revisions to the needs assessment or the analysis process.

Note. If a subcontractor conducts the performance

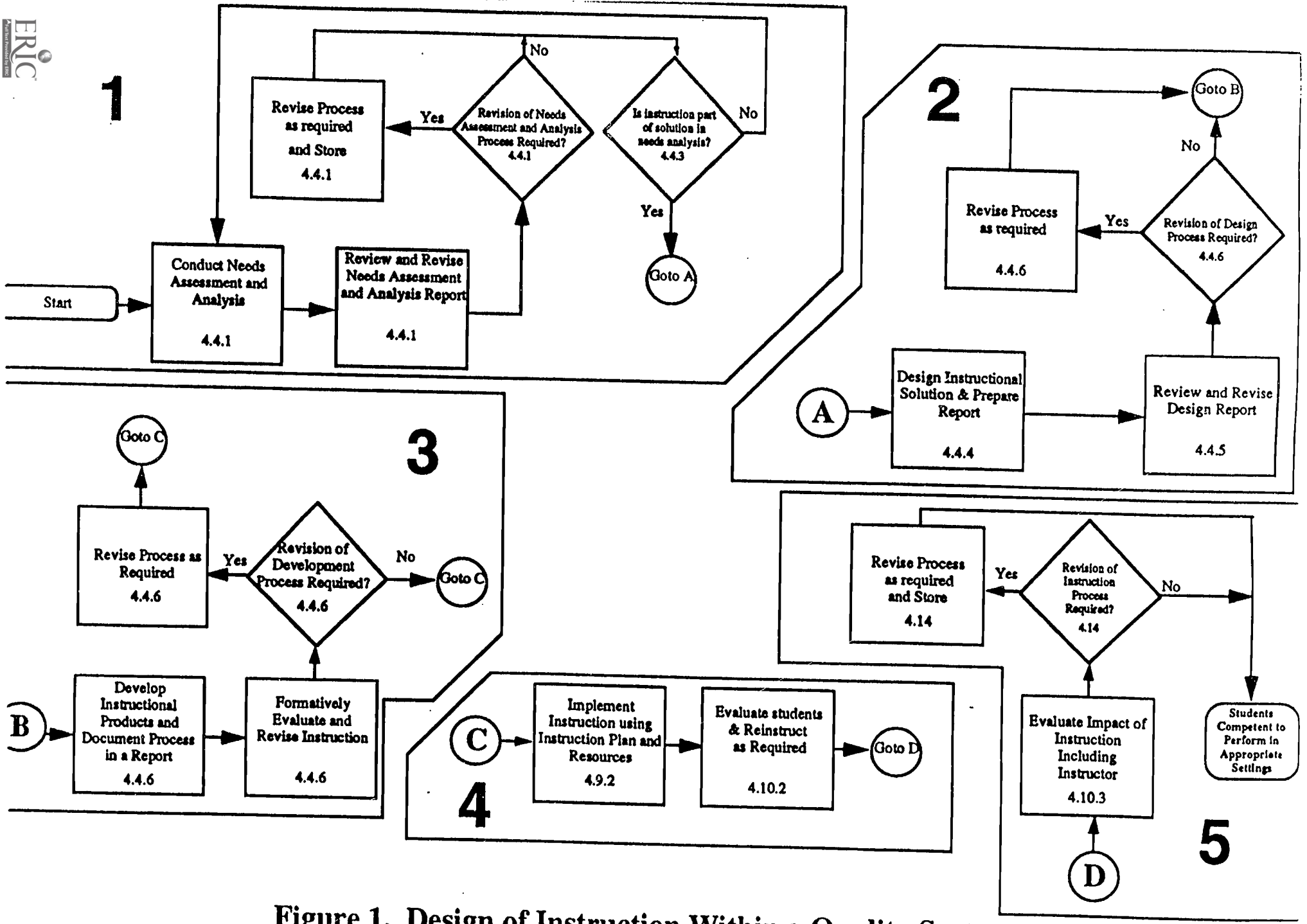


**Figure 1. Design of Instruction Within a Quality System**

**NOTE: Numbers within each box relate to the appropriate section of the guideline.**

assessment for the supplier, the following changes would be noted in the quality system:

a) the subcontractor should document the assessment process that will be used;

b) the subcontractor should produce an assessment which reports results from using a specific assessment process;

c) the instruction supplier should provide the customer with evidence that the subcontractor conducted an assessment review prior to submitting the assessment report.

**4.4.2 Design and development planning**

The supplier shall prepare plans for each design and development activity. The plans shall describe or reference these activities, and define responsibility for their implementation. The design and development activities shall be assigned to qualified personnel equipped with adequate resources. The plans shall be updated, as the design evolves.

**4.4.2 Design and development planning**

Personnel responsible for design/development planning should demonstrate their ability to complete a needs assessment, generate an instructional design, select instructional materials, and complete the development to meet instruction requirements (see 4.18).

**4.4.3 Organizational and technical interfaces**

Organizational and technical interfaces between different groups which input into the design process shall be defined and the necessary information documented, transmitted, and regularly review.

**4.4.3 Organizational and technical interfaces**

Adequately covered by Q9001-1994.

**4.4.4 Design input**

Design-input requirements relating to the product, including applicable statutory and regulatory requirements, shall be identified, documented, and their selection reviewed by the supplier for adequacy. Incomplete, ambiguous, or conflicting requirements shall be resolved with those responsible for imposing these requirements.

Design input shall take into consideration the results of any contract-review activities.

**4.4.4 Design input**

An analysis report should be available to the designer which typically includes stated customer needs, needs which the customer has not yet realized, the overall goals of the instruction, relevant standards, general characteristics of the target population, and any specific quality failures which the training is designed to correct or prevent.

**Design instructional solution**

A design process should be documented and used by designers. The process describes how all skills and knowledge objectives should be identified. Further analyses should be conducted, as required, of relevant target population characteristics and of the environment in which learning and performance take

place. Assessments should be developed for specific criteria (criterion-referenced testing) and instruction and evaluation strategies should be described.

### 4.4.5 Design output

Design output shall be documented and expressed in terms that can be verified against design-input requirements and validated (see 4.4.8).

Design output shall:

a) meet the design-input requirements;

b) contain or make reference to acceptance criteria;

c) identify those characteristics of the design that are crucial to the safe and proper functioning of the product (e.g., operating, storage, handling, maintenance, and disposal requirements).

Design-output documents shall be reviewed before release.

### 4.4.5 Design output

A report of design results should be prepared by the designer who specifies the information called for in the design process and required for the development of the instruction.

The design report should include the following:

a) skills and knowledge to be taught which should be consistent with the analysis report;

b) assessments and evaluations which should be consistent with the objectives and standards;

c) instruction strategies appropriate for the given objectives; and

d) selection of an appropriate medium or combination of media for the delivery system.

### 4.4.6 Design review

At appropriate stages of design, formal documented reviews of the design results shall be planned and conducted. Participants at each design review shall include representatives of all functions concerned with the design stage being reviewed, as well as other specialist personnel, as required. Records of such reviews shall be maintained (see 4.16).

### 4.4.6 Design review

Adequately covered by Q9001-1994.

### 4.4.7 Design verification

At appropriate stages of design, design verification shall be performed to ensure that the design-stage output meets the design-state input requirements. The design-verification measures shall be recorded (see 4.16).

NOTE 10 In addition to conducting design reviews (see 4.4.6), design verification may include activities such as

- performing alternative calculations,

- comparing the new design with a similar proven

### 4.4.7 Design verification

A design report review process should be used for all instructional designs. The review is by people whose areas of responsibility, whenever possible, should differ from those of the design team. These people review the design reports and should be responsible for judging the adequacy of the design to meet the requirements.

**Revision of Design Process**

A review of the design process describes how it should be evaluated and revised in terms of the instruction product which results. The design process

design, if available,

- undertaking tests and demonstrations, and
- reviewing the design-stage documents before release.

should be reviewed and revised by the supplier based upon project-by-project experience and information from the succeeding development and implementation phases.

Note. If a subcontractor designs the instruction for the supplier, then the following changes would be appropriate:

a) the customer's needs analysis report results should be made available to the supplier;

b) the subcontractor states the design used;

c) the subcontractor produces a design report; and

d) the supplier should be provided with evidence that a design review was conducted by the subcontractor prior to submitting the design results report to the customer.

**Development Input**

The Design Results Report specified in 4.4.5 should be made available to the developer.

**Develop instructional materials**

A development process should be documented and used by developers. There may be a specific process statement for each delivery medium, or a generic process for all media. These processes include the sequence of steps in the development process, the personnel involved, the review processes, and associated criteria.

A development report or checklist should be generated along with the development of the instruction to document the procedures used and how they ensured that the instruction meets the design specifications.

**Formatively (during the development of instruction) evaluate and revise instruction**

An instruction review process should be used for all instruction. Personnel who participate in the review and who are responsible for its revisions should be identified. Criteria for acceptance, in terms of readiness for use in instruction, should be specified and include the following:

a) approval of content accuracy by one or more

subject-matter specialists who, whenever possible, did not participate in the development of the instruction;

b) approval of the prose, illustrations, and appearance by editorial and graphics specialists;

c) approval, if appropriate, of the technological soundness by a technology specialist;

d) try-out of both the instruction and the criterion-referenced assessments with students from the target population, and revisions made based upon the difficulties experienced by these students. (This is typically referred to as formative evaluation in the training literature.) At least one of the try-outs should be in an environment similar to that in which the instruction will ultimately be used; and

e) availability of all support materials for students as well as procedures and support materials for preparing instructors.

**Revision of development process**

Suppliers describe how the development process should be reviewed and revised based upon project-by-project experience with the process, including any customer complaints which become available during the implementation phase.

Note. If a sub-contractor conducts the development process for the supplier, then the following changes would be made:

a) the supplier's design results report should be made available to the subcontractor;

b) the sub-contractor documents the development process that will be used on the project. The process should include formative evaluation and revision of all instruction. There should be a clear indication of the customer's responsibility, if any, to provide both subject-matter specialists to identify content and students to participate in the developmental try-outs;

c) the sub-contractor produces instruction that correspond to the design specifications; and

d) the customer should be provided with evidence that formative evaluation and revision were

conducted by the sub-contractor prior to giving instruction to the customer.

**4.4.8 Design validation**

Design validation shall be performed to ensure that product conforms to defined user needs and/or requirements.

NOTES

11 Design validation follows successful design verification (see 4.4.7).

12 Validation is normally performed under defined operating conditions.

13 Validation is normally performed on the final product, but may be necessary in earlier stages prior to product completion.

14 Multiple validations may be performed if there are different intended uses.

**4.4.8 Design validation**

Adequately covered by Q9001-1994.

**4.4.9 Design changes**

All design changes and modification shall be identified, documented, reviewed, and approved by authorized personnel before their implementation.

**4.4.9 Design changes**

Adequately covered by Q9001-1994.

**4.5 DOCUMENT AND DATA CONTROL**

**4.5.1 General**

The supplier shall establish and maintain documented procedures to control all documents and data that relate to the requirements of this American National Standard including, the extent applicable, documents of external origin such as standards and customer drawings.

NOTE 15 Documents and data can be in the form of any type of media, such as hard copy or electronic media.

**4.5 DOCUMENT AND DATA CONTROL**

**4.5.1 General**

Adequately covered by Q9001-1994.

**4.5.2 Document and data approval and issue**

The documents and data shall be reviewed and approved for adequacy by authorized personnel prior to issue. A master list or equivalent document-control procedure identifying the current revision status of documents shall be established and be readily available to preclude the use of

**4.5.2 Document and data approval and issue**

Documents used to define, direct, and control important activities within education and training institutions should be controlled (see 4.9). Documents generated internally should be reviewed and approved for adequacy.

invalid and/or obsolete documents.

This control shall ensure that:

a) the pertinent issues of appropriate documents are available at all locations where operations essential to the effective functioning of the quality system are performed;

b) invalid and/or obsolete documents are promptly removed from all points of issue or use, or otherwise assured against unintended use;

c) any obsolete documents retained for legal and/or knowledge-preservation purposes are suitably identified.

Information about the edition, text supplements, or workbooks should be controlled and traceable to the design process. When a textbook or interactive learning program is changed, the design review should be re-performed or revised. Procedures for course registration, formats for lesson plans, instructions on research report formats, and the like, should be maintained to provide everyone with complete and current documents needed to meet their quality responsibilities.

Everyone should participate in an improvement process for assuring that the documents themselves are useful, and properly used. The document control system should include provisions for external documents. (for example, Legislation, Rules, Government Circulars, Accreditation Regulations, etc.)

### 4.5.3 Document and data changes

Changes to documents and data shall be reviewed and approved by the same functions/organizations that performed the original review and approval, unless specifically designated otherwise. The designated functions/organizations shall have access to pertinent background information upon which to base their review and approval.

Where practicable, the nature of the change shall be identified in the document or the appropriate attachments.

### 4.5.3 Document and data changes

Adequately covered by Q9001-1994.

## 4.6 PURCHASING

### 4.6.1 General

The supplier shall establish and maintain documented procedures to ensure that purchased product (see 3.1) conforms to specified requirements.

## 4.6 PURCHASING

### 4.6.1 General

**Instruction Purchases**

Within instructional settings, academic and technical staff as well as teaching assistants should be hired through selection procedures, which should be included in the quality system. Purchase of books, materials for instruction libraries, computer software, computers, courseware, reproduction services, and course supplies should be included in the quality system. Procedures should cover how resources are selected and by whom. Residential, instructional, and food service facilities should also to be considered where they form a part of the contract with the customer.

**4.6.2 Evaluation of subcontractors**

The supplier shall:

a) evaluate and select subcontractors on the basis of their ability to meet subcontract requirements including the quality system and any specific quality-assurance requirements;

b) define the type and extent of control exercised by the supplier over subcontractors. This shall be dependent upon the type of product, the impact of subcontracted product on the quality of final product, and, where applicable, on the quality audit reports and/or quality records of the previously demonstrated capability and performance of subcontractors;

c) establish and maintain quality records of acceptable subcontractors (see 4.16).

**4.6.2 Evaluation of sub-contractors**

Adequately covered by Q9001-1994.

**4.6.3 Purchasing data**

Purchasing documents shall contain data clearly describing the product ordered, including where applicable:

a) the type, class, grade, or other precise identification;

b) the title or other positive identification, and applicable issues of specifications, drawings, process requirements, inspection instructions, and other relevant technical data, including requirements for approval or qualification of product, procedures, process equipment, and personnel;

c) the title, number, and issue of the quality-system standard to be applied.

The supplier shall review and approve purchasing documents for adequacy of the specified requirements prior to release.

**4.6.3 Purchasing data**

Adequately covered by Q9001-1994.

**4.6.4 Verification of purchased product**

**4.6.4 Verification of purchased product**

An instruction suppliers' official announcements, applications, and other descriptive information, should state the right, whenever educational and training institutions afford the customer the right, to verify, at

the instruction site, the suitability of the facilities, the suitability of the academic and technical staff, and conditions for the delivery of the instruction.

**4.6.4.1 Supplier verification at subcontractor's premises**

Where the supplier proposes to verify purchased product at the subcontractor's premises the supplier shall specify verification arrangements and the method of product release in the purchasing documents.

**4.6.4.1 Supplier verification at subcontractor's premises**

Adequately covered by Q9001-1994.

**4.6.4.2 Customer verification of subcontracted product**

Where specified in the contract, the supplier's customer or the customer's representative shall be afforded the right to verify at the subcontractor's premises and the supplier's premises that subcontracted product conforms to specified requirements. Such verification shall not be used by the supplier as evidence of effective control of quality by the subcontractor.

Verification by the customer shall not absolve the supplier of the responsibility to provide acceptable product, nor shall it preclude subsequent rejection by the customer.

**4.6.4.2 Customer verification of subcontracted product**

Adequately covered by Q9001-1994.

**4.7 CONTROL OF CUSTOMER-SUPPLIED PRODUCT**

The supplier shall establish and maintain documented procedures for the control of verification, storage, and maintenance of customer-supplied product provided for incorporation into the supplies or for related activities. Any such product that is lost, damaged, or is otherwise unsuitable for use shall be recorded and reported to the customer (see 4.16).

Verification by the supplier does not absolve the customer of the responsibility to provide acceptable product.

**4.7 CONTROL OF CUSTOMER-SUPPLIED PRODUCT**

**Purchaser Supplied Materials** (Items which students are required to bring to class)

This covers items such as textbooks, workbooks, case studies, special education provision, computers, software, art supplies, or facilities supplied by companies which purchase instruction for employees. As appropriate, standards and specifications may be established for supplied materials to ensure suitability for use in instruction.

## 4.8 PRODUCT IDENTIFICATION AND TRACEABILITY

Where appropriate, the supplier shall establish and maintain documented procedures for identifying the project by suitable means from receipt and during all stages of production, delivery, and installation.

Where and to the extent that traceability is a specified requirement, the supplier shall establish and maintain documented procedures for unique identification of individual product or batches. This identification shall be recorded (see 4.16).

## 4.8 PRODUCT IDENTIFICATION AND TRACEABILITY

(Tracking instruction and performance)

For most purposes, while attendance records and transcripts can be used to identify what courses were presented when to each student, the following data system should improve the ability to verify more precisely the instruction provided:

a) student course records;
b) the course syllabus;
c) the class schedule;
d) textbook and edition;
e) list of instructors' names;
f) instruction materials; and
g) relevant pre-requisite knowledge or experience.

## 4.9 PROCESS CONTROL

The supplier shall identify and plan the production, installation, and servicing processes which directly affect quality and shall ensure that these processes are carried out under controlled conditions. Controlled conditions shall include the following:

a) documented procedures defining the manner of production, installation, and servicing, where the absence of such procedures could adversely affect quality;

b) use of suitable production, installation, and servicing equipment, and a suitable working environment;

c) compliance with reference standards/codes, quality plans, and/or documented procedures;

d) monitoring and control of suitable process parameters and product characteristics;

e) the approval of processes and equipment, as appropriate;

f) criteria for workmanship, which shall be stipulated in the clearest practical manner (e.g., written standards, representative samples, or illustrations;

g) suitable maintenance of equipment to ensure continuing process capability.

## 4.9 PROCESS CONTROL

Instructional processes should be controlled to assure the attainment of the desired outcomes. In education and training institutions, control may be considered as the identification of important activities, measures of those activities, and clearly defined levels of acceptability.

### General

The major instructional processes which should be controlled may include needs assessment; instructional design, development, and delivery; and outcomes measurement. The major support processes described in Q9001 or Q9002 should also be controlled. For institutions selecting Q9001, all control methods may be established by instructors. For those selecting Q9002, control methods may be established by those who conduct needs assessment, who design instruction, or who develop instruction, while the control of various processes may be the responsibility of people other than the instructors. In either case, the control methods should be part of the management review to assure that instructional specifications are met and that the control methods are consistent with accepted quality practices. Changes in the control of these major processes should be documented and the instruction should be evaluated after any change has taken place.

Note: The control of instruction may sometimes be seen as a threat to academic freedom or an encroachment by administrators into the professional judgment of the instructor. In practice, in the United

Where the results of processes cannot be fully verified by subsequent inspection and testing of the product and where, for example, processing deficiencies may become apparent only after the product is in use, the processes shall be carried out by qualified operators and/or shall require continuous monitoring and control of process parameters to ensure that the specified requirements are met.

The requirements for any qualification of process operations, including associated equipment and personnel (see 4.18), shall be specified.

NOTE 16 Such processes requiring prequalification of their process capability are frequently referred to as special processes.

Records shall be maintained for qualified processes, equipment, and personnel, as appropriate (see 4.16).

Kingdom for example, the instructors are asked to write down their plan to control quality. Observations are made to verify how they do control quality. A check is made to identify differences between the two. Finally, the instructor is asked to act to adjust any differences. This same approach is applied to the support processes with direct involvement of those responsible for a particular process.

**Special Processes**

All education and training processes are special processes in the sense of this clause of Q9001-1994. The guidance provided throughout Z-1.11 is intended to meet the requirements of Q9001-1994.

Implement Instruction using Instructional Plan and Resources Plan

If the materials and strategies to be used in instruction have not been developed according to this guideline, then an Instructional Plan should be available which describes the prerequisites, objectives, standards for assessments, instructional strategies, necessary controls, mechanics for post-course completion follow-up of student learning, and the associated role of all the materials that have been selected for use in the instruction. A needs assessment and analysis results report should be available which relates a student outcome to an instruction need.

**Instructional Unit Plan**

An instructional plan for any unit of instruction should describe, at a minimum, the role, and activities of the instructor and students during the instruction. (In instructor-led instruction this document is often an Instructor Guide. Where instruction is led by students, computers, video tape, etc., there should be a similar description of the flow of the instruction.) The plan should also indicate both the methods and the criteria for the evaluation of courses (including post-completion), course improvement, real-time feedback to students, students' progress, and corrective action.

**Instruction Personnel Evaluation**

Personnel responsible for the instruction process should be able to demonstrate or document their ability to deliver complete instruction as specified. Evidence includes reports on results of classroom observations, formal academic training, and/or

documented teaching experience. Employment records should indicate how qualifications were established and what additional training was provided.

Note. Should a sub-contractor be hired to deliver the instruction in this phase, then an additional standard should be met, and prior standards modified as follows:
Contract or Sub-contract Instructors should be selected on the basis of documented teaching experience and knowledge of instructional techniques. If the customer does not own or is unable to change the instruction that is delivered, then the contract should specify that:

a) the customer should be provided a complete review of the instruction prior to its delivery;

b) the instruction will be consistent with objectives and assessments upon which the subcontractor and the customer have agreed; and

c) an Instruction Record should be filed by the contract instructor for each administered course.

## 4.10 INSPECTION AND TESTING

### 4.10.1 General

The supplier shall establish and maintain documented procedures for inspection and testing activities in order to verify that the specified requirements for the product are met. The required inspection and testing, and the records to be established, shall be detailed in the quality plan or documented procedures.

### 4.10.2 Receiving inspection and testing

4.10.2.1 The supplier shall ensure that incoming product is not used or processed (except in the circumstances described in 4.10.2.3) until it has been inspected or otherwise verified as conforming to specified requirements. Verification of the specified requirements shall be in accordance with the quality plan and/or documented procedures.

4.10.2.2 In determining the amount and nature of receiving inspection, consideration shall be given to the amount of control exercised at the subcontractor's premises and the recorded evidence

## 4.10 INSPECTION AND TESTING

### 4.10.1 General

Adequately covered by Q9001-1994.

### 4.10.2 Receiving inspection and testing
(Entrance or diagnostic examinations)

The aptitude and ability of each entering student should be assessed to ensure that the instructio is provided at an appropriate level and at an appropriate pace. Advertising, course brochures, and other items produced by the instruction supplier should state clearly how prior education, training, and experience are related to the learning needs of students. The absence of specific entrance requirements need not negate an assessment of individual student needs which may be then used to adjust the instruction to those individual needs.

of conformance provided.

4.10.2.3 Where incoming product is released for urgent production purposes prior to verification, it shall be positively identified and recorded (see 4.16) in order to permit immediate recall and replacement in the event of nonconformity to specified requirements.

Inspection should also include new equipment, services supplied, video tapes, computers, software, over-heads, and other materials used in instruction.

**4.10.3 In-process inspection and testing**

a) inspect and test the product as required by the quality plan and/or documented procedures;

b) hold product until the required inspection and tests have been completed or necessary reports have been received and verified, except when product is released under positive-recall procedures (see 4.10.2.3). Release under positive-recall procedures shall not preclude the activities outlined in 4.10.3a.

**4.10.3 In-process inspection and testing** (Formative evaluation as conducted during the instruction)

This covers checks and examinations carried out during the instruction to assure compliance with the plan. This could include student performance profiles, assessments of staffing records, written course assessments, observations which note whether instructors are following the plan, and final examinations.

**4.10.4 Final inspection and testing**

The supplier shall carry out all final inspection and testing in accordance with the quality plan and/or documented procedures to complete the evidence of conformance of the finished product to the specified requirements.

The quality plan and/or documented procedures for final inspection and testing shall require that all specified inspection and tests, including those specified either on receipt of product or in-process, have been carried out and that the results meet specified requirements.

No product shall be dispatched until all the activities specified in the quality plan and/or documented procedures have been satisfactorily completed and the associated data and documentation are available and authorized.

**4.10.4 Final Inspection and Testing** (Summative evaluation at the end of the instruction)

For all instruction this covers any assessments, tests, or examinations which should be given to evaluate instructional effectiveness and/or the performance of the students. The evaluation method should depend upon the instruction specification or the curriculum. A range of measures from observation of performance to a full set of examinations may be used. Procedures ensure that students should not be certified until all instruction requirements are fulfilled. In addition to the above, procedures should ensure that all assessments, reviews, and examinations have been conducted and documented. Final inspection of course materials should include accuracy, currency, and usefulness and may recommend needed revisions to the instruction.

**Post-Instruction Inspection and Testing** (Impact evaluation some time after the instruction)

When follow-up of graduates identifies omitted or incorrect instruction, the instruction supplier may wish to recall the materials and/or notify the students to provide missing or corrected instruction at no additional cost.
Note: This is becoming a common practice for vocational training institutions.

4.10.5 Inspection and test records

The supplier shall establish and maintain records which provide evidence that the product has been inspected and/or tested. These records shall show clearly whether the product has passed or failed the inspections and/or tests according to defined acceptance criteria. Where the product fails to pass any inspection and/or test, the procedures for control of nonconforming product shall apply (see 4.13).

Records shall identify the inspection authority responsible for the release of product (see 4.16).

4.10.5 Inspection and Test Records (Transcripts)

There should be documentary evidence of completion of all assessments and evaluations. A system should exist for retention of these records for a specified time period.

## 4.11 CONTROL OF INSPECTION, MEASURING, AND TEST EQUIPMENT

### 4.11.1 General

The supplier shall establish and maintain documented procedures to control, calibrate, and maintain inspection, measuring, and test equipment (including test software) used by the supplier to demonstrate the conformance of product to the specified requirements. Inspection, measuring, and test equipment shall be used in a manner which ensures that the measurement uncertainty is known and is consistent with the required measurement capability.

Where test software or comparative references such as test hardware are used as suitable forms of inspection, they shall be checked to prove that they are capable of verifying the acceptability of product, prior to release for use during production, installation, or servicing, and shall be rechecked at prescribed intervals. The supplier shall establish the extent and frequency of such checks and shall maintain records as evidence of control (see 4.16).

Where the availability of technical data pertaining to the measurement equipment is a specified requirement, such data shall be made available, when required by the customer or customer's representative, for verification that the measuring equipment is functionally adequate.

NOTE 17 For the purposes of this American National Standard, the term "measuring equipment"

## 4.11 CONTROL OF INSPECTION, MEASURING, AND TEST EQUIPMENT (Laboratory instruments)

### 4.11.1 General

Instruction on instruments which need calibration prior to each use sometimes necessitates an extension of the training to an off-campus, on-site, location which should be included in the quality system.

includes measurement devices.

4.11.2 Control procedure

The supplier shall:

a) determine the measurements to be made and the accuracy required, and select the appropriate inspection, measuring, and test equipment that is capable of the necessary accuracy and precision;

b) identify all inspection, measuring, and test equipment that can affect product quality, and calibrate and adjust them at prescribed intervals, or prior to use, against certified equipment having a known valid relationship to internationally or nationally recognized standards. Where no such standards exist, the basis used for calibration shall be documented;

c) define the process employed for the calibration of inspection, measuring, and test equipment, including details of equipment type, unique identification, location, frequency of checks, check method, acceptance criteria, and the action to be taken when results are unsatisfactory;

d) identify inspection, measuring, and test equipment with a suitable indicator or approved identification record to show the calibration status;

e) maintain calibration records for inspection, measuring, and test equipment (see 4.16);

f) assess and document the validity of previous inspection and test results when inspection, measuring, and test equipment is found to be out of calibration;

g) ensure that the environmental conditions are suitable for the calibrations, inspections, measurements, and tests being carried out;

h) ensure that the handling, preservation, and storage of inspection, measuring, and test equipment is such that the accuracy and fitness for use are maintained;

i) safeguard inspection, measuring, and test facilities, including both test hardware and test

software, from adjustments which would invalidate the calibration setting.

NOTE 18 The metrological confirmation system for measuring equipment given in ISO 10012 may be used for guidance.

### 4.12 INSPECTION AND TEST STATUS

The inspection and test status of product shall be identified by suitable means, which indicate the conformance of nonconformance of product with regard to inspection and tests performed. The identification of inspection and test status shall be maintained, as defined in the quality plan and/or documented procedures, throughout production, installation, and servicing of the product to ensure that only product that has passed the required inspections and tests [or released under an authorized concession (see 4.13.2)] is dispatched, used, or installed.

### 4.12 INSPECTION AND TEST STATUS

In most cases the requirements of this clause should be satisfied through adequate documentation of student records. Facilities and materials status should be included.

### 4.13 CONTROL OF NONCONFORMING PRODUCT

#### 4.13.1 General

The supplier shall establish and maintain documented procedures to ensure that product that does not conform to specified requirements is prevented from unintended use of installation. This control shall provide for identification, documentation, evaluation, segregation (when practical), disposition of nonconforming product, and for notification to the functions concerned.

### 4.13 CONTROL OF NONCONFORMING PRODUCT

#### 4.13.1 General

Nonconformance includes, but is not limited to, instruction specification, instructor and student performance, materials, and services purchased for instruction.

#### 4.13.2 Review and disposition of nonconforming product

The responsibility for review and authority for the disposition of nonconforming product shall be defined.

Nonconforming product shall be reviewed in accordance with documented procedures. It may be

a) reworked to meet the specified requirements,

b) accepted with or without repair by concession,

#### 4.13.2 Review and disposition of nonconforming product (Academic or administrative actions)

This is the action which should be taken as a result of any nonconformity of the instruction delivered. The four processes referred to in Z-1.11 (4.9.1) should to be examined to determine the cause of the nonconformance. Nonconformity may include inadequate student participation in the instruction process and, where permitted by law, students may be:

a) provided additional instruction and permitted to re-take a test or a course or re-submit a piece of

c) regraded for alternative applications, or

d) rejected or scrapped.

Where required by the contract, the proposed use of repair of product (see 4.132b) which does not conform to specified requirements shall be reported for concession to the customer or customer's representative. The description of the nonconformity that has been accepted, and of repairs, shall be recorded to denote the actual condition (see 4.16).

Repaired and/or reworked product shall be reinspected in accordance with the quality plan and/or documented procedures.

## 4.14 CORRECTIVE AND PREVENTIVE ACTION

### 4.14.1 General

The supplier shall establish and maintain documented procedures for implementing corrective and preventive action.

Any corrective or preventive action taken to eliminate the causes of actual or potential nonconformities shall be to a degree appropriate to the magnitude of problems and commensurate with the risks encountered.

The supplier shall implement and record any changes to the documented procedures resulting from corrective and preventive action.

### 4.14.2 Corrective action

The procedures for corrective action shall include:

a) the effective handling of customer complaints and reports of product nonconformities;

b) investigation of the cause of nonconformities relating to product, process, and quality system, and recording the results of the investigation (see 4.16);

c) determination of the corrective action needed to eliminate the cause of nonconformities;

work;

b) permitted to continue at the teacher's discretion;

c) transferred to another program of study; or

d) requested to leave.

It may be necessary to revise instruction specifications, instruction, support materials or tools.

## 4.14 CORRECTIVE AND PREVENTIVE ACTION

### 4.14.1 General

Systems address customer complaints, student comments, the results of quality audits, retention rates, and success rates. There should be a system for monitoring corrective actions within design, development, and delivery as well as an analysis to ensure that solutions are effective and are related to root causes. In any case, evaluation should be designed to identify root causes before corrective action is taken.

### 4.14.2 Corrective action

Some examples of corrective action follow; e.g., a course or workshop may be:

a) revised; or
b) terminated.

An instructor may be:

a) re-trained; or
b) replaced.

An instruction record should contain the written test scores or data from other objective assessments. The

d) application of controls to ensure that corrective action is taken and that it is effective.

record should also note the students who did not reach an acceptable performance level on the first attempt and how they were provided additional instruction, eventually succeeded, or engaged in alternative activities.

An instruction review process should be used with each administration of a course. The related document identifies who participates in the review, who is responsible for revisions to the course, and who is responsible for any students who did not reach a required performance level.

Criteria for instruction reviews include information on the following:

a) students not learning the desired outcomes;

b) proportion of students who had concerns about certain aspects of the instruction;

c) instructor comments about aspects of the instructional strategy and/or materials;

d) subject-matter specialists' comments about required changes in the content and delivery of the instruction;

e) evidence of a change in the need for the skills taught in the instruction; and

f) customer comments as to adequacy of course materials as applied by the students.

### 4.14.3 Preventive action

The procedures for preventive action shall include:

a) the use of appropriate sources of information such as processes and work operations which affect product quality, concessions, audit results, quality records, service reports, and customer complaints to detect, analyze, and eliminate potential causes of nonconformities;

b) determination of the steps needed to deal with any problems requiring preventive action;

c) initiation of preventive action and application of controls to ensure that it is effective;

d) confirmation that relative information on actions

### 4.14.3 Preventive Action

In education and training institutions, preventive action is a step that is to be taken early in the system development process, in contrast to corrective action, which is characteristically taken at a later stage. Preventive action should, like statistics (4.20), be considered for every quality system element. Understanding education and training processes and applying statistical approaches early in the processes presents opportunities to take preventive action, and increases the likelihood that such actions will be effective.

taken is submitted for management review (see 4.1.3).

## 4.15 HANDLING, STORAGE, PACKAGING, PRESERVATION, AND DELIVERY

### 4.15.1 General

The supplier shall establish and maintain documented procedures for handling, storage, packaging, preservation, and delivery of product.

### 4.15.2 Handling

The supplier shall provide methods of handling product that prevent damage or deterioration.

### 4.15.3 Storage

The supplier shall use designated storage areas or stock rooms to prevent damage or deterioration of product, pending use or delivery. Appropriate methods for authorizing receipt to and dispatch from such areas shall be stipulated.

In order to detect deterioration, the condition of product in stock shall be assessed at appropriate intervals.

### 4.15.4 Packaging

The supplier shall control packing, packaging, and marking processes (including materials used) to the extent necessary to ensure conformance to specified requirements.

### 4.15.5 Preservation

The supplier shall apply appropriate methods for preservation and segregation of product when the product is under the supplier's control.

### 4.15.6 Delivery

The supplier shall arrange for the protection of the quality of product after final inspection and test. Where contractually specified, this protection shall be extended to include delivery to destination.

## 4.15 HANDLING, STORAGE, PACKAGING, PRESERVATION, AND DELIVERY

(Only limited application to instructional materials)

### 4.15.1 General

There may be some limited applications of this element in Q9001 or Q9002 which include the method of delivery, how materials should be presented to the student, equipment that needs to be available (e.g., video tapes), etc. For resident students there may be services which should be provided such as health, counseling, personal safety, lodgings, food services, etc., but most sections of this element do not apply. Therefore, 4.15.2, 4.15.3, 4.15.4, and 4.15.5 of Q9001 should be omitted here.

## 4.16 CONTROL OF QUALITY RECORDS

The supplier shall establish and maintain documented procedures for identification, collection, indexing, access, filing, storage, maintenance, and disposition of quality records.

Quality records shall be maintained to demonstrate conformance to specified requirements and the effective operation of the quality system. Pertinent quality records from the subcontractor shall be an element of these data.

All quality records shall be legible and shall be stored and retained in such a way that they are readily retrievable in facilities that provide a suitable environment to prevent damage or deterioration and to prevent loss. Retention times of quality record shall be established and recorded. Where agreed contractually, quality records shall be made available for evaluation by the customer or the customer's representative for an agreed period.

NOTE 19 Records may be in the form of any type of media, such as hard copy or electronic media.

## 4.17 INTERNAL QUALITY AUDITS

The supplier shall establish and maintain documented procedures for planning and implementing internal quality audits to verify whether quality activities and related results comply with planned arrangements and to determine the effectiveness of the quality system.

Internal quality audits shall be scheduled on the basis of the status and importance of the activity to be audited and shall be carried out by personnel independent of those having direct responsibility for the activity being audited.

The results of the audits shall be recorded (see 4.16) and brought to the attention of the personnel having responsibility in the areas audited. The management personnel responsible for the area shall take timely corrective action on deficiencies found during the audit.

Follow-up audit activities shall verify and record the implementation and effectiveness of the corrective action taken (see 4.16).

## 4.16 CONTROL OF QUALITY RECORDS

Student records and instruction records are typically maintained by instruction suppliers within the guidelines of privacy protection. In addition, the following records should be a part of the quality system:

a) Needs Assessment Results Report;
b) Design Results Report;
c) Development Report or Checklist;
d) Instructional Plan;
e) Instruction and Support Materials;
f) Instruction Record;
g) Impact Evaluation;
h) Student Performance Records and Instruction Reviews;
i) Evidence of completion (Certificate, Credit, Diploma, etc.);
j) Loss, Damage, or Unsuitable Use of Customer Supplied Materials;
k) Complaints;
l) Participation in Research;
m) Prerequisite Skills; and
n) Copyright Records or Permission to use Information.

## 4.17 INTERNAL QUALITY AUDITS

Adequately covered by Q9001-1994.

NOTES

20 The results of internal quality audits form an integral part of the input to management review activities (see 4.1.3).

21 Guidance on quality-system audits is given in ANSI/ASQC Q10011-1-1994, ANSI/ASQC Q10011-2-1994, and ANSI/ASQC Q10011-3-1994.

## 4.18 TRAINING

The supplier shall establish and maintain documented procedures for identifying training needs and provide for the training of all personnel performing activities affecting quality. Personnel performing specific assigned tasks shall be qualified on the basis of appropriate education, training and/or experience, as required. Appropriate records of training shall be maintained (see 4.16).

## 4.18 TRAINING

The customer needs to be assured that the instruction supplier has the qualified instructional personnel to meet customers' instructional needs. The academic degrees held by instructors, employment history, special courses or certificates, in-service training, and written procedures and instructions should be a part of the quality records.

Qualifications should be reviewed periodically to identify and provide necessary in-service training to all instructors and staff to allow instruction personnel to carry out their tasks with minimal supervision. If in-service is not available and this impairs the quality of the instruction, then a staff communication procedure within the quality system should be considered to redress this. Records should show a periodic review of training needs.

The responsibility and authority of all teachers/trainers, support staff, and administrators who verify instruction should be documented. Responsibilities and appropriate actions should be defined in order to identify, record, and solve problems for students who do not meet instruction specifications in a timely manner and whose needs are not met.

## 4.19 SERVICING

Where servicing is a specified requirement, the supplier shall establish and maintain documented procedures for performing, verifying, and reporting that the servicing meets the specified requirements.

## 4.19 SERVICING

If a contract agreement requires on-going support of students after completion of their program of studies, the supplier should indicate how such support will be given and monitored. One portion of this requirement should be satisfied by impact evaluation. (see 3.0 and 4.10.3)

## 4.20 STATISTICAL TECHNIQUES

### 4.20.1 Identification of need

The supplier shall identify the need for statistical techniques required for establishing, controlling, and verifying process capability and product characteristics.

### 4.20.2 Procedures

The supplier shall establish and maintain documented procedures to implement and control the application of the statistical techniques identified in 4.20.1.

## 4.20 STATISTICAL TECHNIQUES

Statistical techniques should apply to all aspects of the quality system. Evidence of statistical analysis of the variability for such measures as performance indicators, dropout rates, achievement records, customer satisfaction, and trend analysis can assure customers that effective process control is a part of the quality system.

Instructional processes often have quantitative as well as qualitative characteristics.

Examples of quantitative instruction characteristics include: instruction time, waiting time, student performance, dropout rates, costs, reliability and validity of examinations, student places available, course transfer rates, retraining time by local businesses, number of textbooks, instruction support resources, degrees, and advanced degrees granted.

Examples of qualitative instruction characteristics include: credibility, accessibility, security, responsiveness, courtesy, comfort, competence, dependability, esteem, usefulness, aesthetics of environment, and hygiene.

Measurement and evaluation should be continuous and direct during the instruction. Effectiveness is not always known until the enhanced skills and knowledge are applied, but the customer needs to be assured that predictions of successful application are made with appropriate statistical precision.

Statistical procedures used to reduce errors of estimate should be recorded.

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SCANS

# LEARNING A LIVING: A BLUEPRINT FOR HIGH PERFORMANCE

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# A SCANS REPORT FOR AMERICA 2000

THE SECRETARY'S COMMISSION ON ACHIEVING NECESSARY SKILLS
U.S. DEPARTMENT OF LABOR
APRIL 1992

# LEARNING A LIVING:
# A BLUEPRINT FOR HIGH PERFORMANCE

# EXECUTIVE SUMMARY

# PRINCIPLES AND RECOMMENDATIONS

The Secretary's Commission on Achieving Necessary Skills (SCANS) was appointed by the Secretary of Labor to determine the skills that our young people need to succeed in the world of work. The Commission's fundamental purpose is to encourage a high-performance economy characterized by high-skill, high-wage employment.

Our primary message to schools is this: Look beyond the schoolhouse to the roles students will play when they leave to become workers, parents, and citizens.

Our message to teachers is this: Look beyond your discipline and your classroom to the other courses your students take, to your community, and to the lives of your students outside school. Help your students connect what they learn in class to the world outside.

Our message to employers is this: Look outside your company and change your view of your responsibilities for human resource development. Your old responsibilities were to select the best available applicants and to retain those you hired. Your new responsibilities must be to improve the way you organize work and to develop the human resources in your community, your firm, and your nation.

We want to state at the outset that the well-being of the nation—and its citizens—is *not* synonymous with economic status. There is much more to life than earning a living, and we want more from schools than productive workers. We want citizens who can discharge the responsibilities that go with living in a democratic society and with being parents. As we said in our first report: "A solid education is its own reward and has value beyond specific skills." We are not talking about turning our high schools into trade schools. Nor do we suggest that schools ignore the beauty of literature and scientific theories or the lessons of history and geography.

SCANS focused on one important aspect of schooling: what we call the "learning a living" system. In 1991 SCANS issued its initial report, *What Work Requires of Schools*. As outlined in that report, a high-performance workplace requires workers who have a solid foundation in the basic literacy and computational skills, in the thinking skills necessary to put knowledge to work, and in the personal qualities that make workers dedicated and trustworthy.

But a solid foundation is not enough. High-performance workplaces also require competencies: the ability to manage resources, to work amicably and productively with others, to acquire and use information, to master complex systems, and to work with a variety of technologies. This combination of foundation skills and workplace competencies—"workplace know-how" (see Exhibit 1)—is not taught in many schools or required for most diplomas.

## EXHIBIT 1

### WORKPLACE KNOW-HOW

The know-how identified by SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. These are:

WORKPLACE COMPETENCIES: — Effective workers can productively use:

- **Resources**—They know how to allocate time, money, materials, space, and staff.
- **Interpersonal skills**—They can work on teams, teach others, serve customers, lead, negotiate, and work well with people from culturally diverse backgrounds.
- **Information**—They can acquire and evaluate data, organize and maintain files, interpret and communicate, and use computers to process information.
- **Systems**—They understand social, organizational, and technological systems; they can monitor and correct performance; and they can design or improve systems.
- **Technology**—They can select equipment and tools, apply technology to specific tasks, and maintain and troubleshoot equipment.

FOUNDATION SKILLS: — Competent workers in the high-performance workplace need:

- **Basic Skills**—reading, writing, arithmetic and mathematics, speaking, and listening.
- **Thinking Skills**—the ability to learn, to reason, to think creatively, to make decisions, and to solve problems.
- **Personal Qualities**—individual responsibility, self-esteem and self-management, sociability, and integrity.

The time when a high school diploma was a sure ticket to a job is within the memory of workers who have not yet retired; yet in many places today a high school diploma is little more than a certificate of attendance. As a result, employers discount the value of all diplomas, and many students do not work hard in high school.

In fact, the market value of a high school diploma has fallen. The proportion of men between the ages of 25 and 54 with high

school diplomas who earn less than enough to support a family of four above the poverty line is growing alarmingly. Among African-American men with 12 years of schooling, the proportion with low earnings rose from 20 percent in 1969 to 42.7 percent in 1989; among Hispanic men, from 16.4 to 35.9 percent; and among white men, from 8.3 percent to 22.6 percent. In other words, in 1989 more than two in five African-American men, one in three Hispanic men, and one in five white men, all with high school diplomas, did not earn enough to lift a family of four above poverty. Unless there is a second earner, their families will not have what most would call a decent living.

The workplace know-how that this Commission has defined is related both to competent performance and to higher earnings for the people who possess it. When the Commission compared the know-how required in 23 high-wage jobs with the requirements of 23 low-wage jobs, the conclusion was inescapable: workers with more know-how command a higher wage—on average, 58 percent, or $11,200 a year, higher.

Everyone must have the opportunity to reach the higher levels of skills and competencies the Commission found to be associated with high-wage jobs. To that end, we have recast the broad principles set forth in *What Work Requires of Schools* as the context for our recommendations:

- **The qualities of high performance that today characterize our most competitive companies must become the standard for the vast majority of our employers, public and private, large and small, local and global.**
- **The nation's schools must be transformed into high-performance organizations.**
- **All Americans should be entitled to multiple opportunities to learn the SCANS know-how well enough to earn a decent living.**

To make those principles a reality we recommend:

1. **The nation's school systems should make the SCANS foundation skills and workplace competencies explicit objectives of instruction at all levels.**
2. **Assessment systems should provide students and workers with a résumé documenting attainment of the SCANS know-how.**
3. **All employers, public and private, should incorporate the SCANS know-how into all their human resource development efforts.**
4. **The Federal Government should continue to bridge the gap between school and the high-performance workplace, by advancing the SCANS agenda.**
5. **Every employer in America should create its own strategic vision around the principles of the high-performance workplace.**

## IMPLEMENTATION

The Commission recognizes that nationwide policies are of little value until they are carried out by people on the front line. Cities such as Fort Worth, Los Angeles, Pittsburgh, Tampa,

and Louisville and states such as Florida, Indiana, New York, and Oregon have taken steps to put the broad SCANS principles in place in their school systems at the local and state levels. In the corporate sector, TGI Friday's, MCI, Gannett, Motorola, NationsBank, and AT&T (and its major unions) are taking action. A number of trade organizations in the hospitality field have joined together to introduce the SCANS language into their industry. The U.S. Department of Labor is moving to build SCANS into various aspects of Job Training Partnership Act programs. The Federal Government's Office of Personnel Management (OPM) is seeking ways to apply SCANS findings in skills centers for Federal employees.

These leaders and those who follow them can begin the systemic change to a high-performance future. In the process they will have to reinvent education, reorganize work and work-based learning, and restructure educational assessment.

## REINVENTING K-12 EDUCATION

During the 1980s the United States, seeking to improve public schools, tried to get more results through tighter curricula, higher certification standards for teachers, and more testing of everyone. Despite the effort, students were performing essentially no better at the end of the decade than they were at the beginning. More of the same was not a successful strategy.

As this Commission argued in *What Work Requires of Schools*, American society today requires that elementary and secondary schools meet drastically different goals. The job now is to bring all students to a level that, in the past, only a small minority reached. Experts universally agree that this job requires reinventing elementary and secondary education.

President Bush and the nation's governors have agreed on a set of six goals for education. These goals have been generally agreed to by state governments, education leaders, and business groups such as the Business Roundtable. The Commission supports all six goals; its recommendations are particularly pertinent to the two goals that refer to preparing youth and adults for productive employment in our competitive economy.

The experience of schools, districts, and states that are advancing toward high-performance schooling provides important lessons for educators wishing to teach the SCANS know-how:

- **Teaching should be offered "in context," that is, students should learn content while solving realistic problems. "Learning in order to know" should not be separated from "learning in order to do."**
- **Improving the match between what work requires and what students are taught requires changing how instruction is delivered and how students learn.**
- **High performance requires a new system of school administration and assessment.**
- **The entire community must be involved.**

The experience of Fort Worth, Texas, with restructuring its instructional program has

shown how the SCANS classroom can differ from the traditional classroom. In Fort Worth, the conventions of today's classroom (teacher omniscience, student passivity and isolation, rigid disciplinary borders, and "abstracted" knowledge and facts) are being replaced with sophisticated and more realistic concepts of instruction and learning (the teacher may not know all the answers, students often learn best in groups, and knowledge is related to real problems).

### Resources

Of all the resources required for reinventing schools around the SCANS ends, none are more important than those devoted to teacher training and staff development. Providing training opportunities for instructional staff will be costly, especially if teachers and administrators are to be given the time they need during the school day and summers for training. But teachers, noninstructional staff, and building and school-district administrators need time if they are to:

- Develop new pedagogical skills required to teach in context and to develop active, collaborative learning environments;
- Learn new instructional management skills and use new instructional technologies to develop new ways of interacting with students; and
- Gain experience with the principles of high performance as applied in restructured workplaces.

Emerging instructional technologies promise to revolutionize teaching and learning by enabling teachers and students to change their traditional roles. When technology dispenses information, teachers are free to coach and facilitate student learning. With technology monitoring learning, students can become active learners, working to acquire new skills.

The SCANS competencies cannot be widely taught unless teachers have instructional materials: textbooks and other print materials, and computer-based and multimedia materials. Video and multimedia materials are essential to creating the realistic contexts in which the competencies are used.

### Equity and Diversity

The changes advocated by the Commission promise great benefits to minority and low-income Americans. One-third of new entrants into the American labor force are members of minority groups; they are entitled to an education that will let them learn and will equip them to find and hold a decent job. Because children vary, not only as individuals but also as members of different cultural, racial, and ethnic groups, education must take into account three basic elements that contribute to this diversity:

1. Differences in family income,
2. Limited English-speaking proficiency (LEP), and
3. Differences in learning styles.

Variation and diversity are not the enemies of high-quality education. The enemy is rigid insistence on a factory model of schooling, a prescription for failure that refuses to accommo-

date diversity or to allow those students with special strengths to function productively.

## REORGANIZING FOR HIGH-PERFORMANCE WORK AND WORK-BASED LEARNING

Both high-performance workplaces and highly trained workers are needed if we are to build a high-skilled, high-wage economy. Reinventing K-12 education is necessary but not sufficient because about 80 percent of the workers on whom American employers will depend as we enter the 21st century are already on the job. To create high-performance workplaces, employers must actively work to develop the skills and competence of these workers. Only in this way can they constantly improve the quality of the goods and services they provide and satisfy their customers' needs.

Every American employer, public or private, large or small, local or global, must consider the human resources needed for high performance and high quality. Yet, today, American companies do much less training than some of our international competitors; in fact, fewer than 10 percent of front-line American workers now receive training of any kind.

The Commission believes that employer-sponsored training, both public and private, must be upgraded and organized around the SCANS know-how. As a useful first step, coalitions of trade associations, business organizations, labor unions, and industry-specific groups could develop training strategies and materials around the SCANS know-how for use by all businesses, particularly small firms.

Many young people between the ages of 16 to 25 today are frustrated because their high schools talked of English and geometry, but their workplace speaks a different language. In a system that serves people beyond high school, employers would describe job requirements in terms of the SCANS workplace competencies and use these for recruitment and employee development. Human resource and training managers would reorient their education and training offerings to include not only job-specific skills but also the SCANS workplace competencies and foundation skills.

Providers of education—vocational schools, proprietary schools, community colleges, adult education, and work-based programs—would offer instruction and certification in SCANS workplace competencies. Referral agencies—job counselors in high schools, in employment agencies and the Employment Service, or in the skill centers newly recommended by the Administration—would assess their clients' SCANS workplace competencies, understand job and educational requirements and opportunities in the same terms, and refer clients to career-enhancing work and education.

## RESTRUCTURING EDUCATIONAL ASSESSMENT

A system for assessing and certifying the SCANS workplace know-how is essential. If employers and colleges pay attention to the SCANS foundation skills and workplace compe-

tencies, students will work to acquire them. If teachers have to certify that the know-how is acquired, they will make the effort to teach it. If parents and community groups understand the standards that graduates are expected to attain, they will demand that their children reach these levels.

The Commission supports the emerging national consensus calling for a new, nationwide, voluntary assessment system. The Commission believes the system should incorporate new techniques of judging performance—not "tests" as traditionally understood, but assessment tied to learning goals. The National Council on Education Standards and esting has endorsed the inclusion of the SCANS workplace competencies in the system it recommended, stating that the SCANS competencies "can and should be integrated into the national standards and assessments."[1] The Commission hopes that the curriculum development work of several groups—the National Council of Teachers of Mathematics, the National Council of Teachers of English, the National Science Teachers Association, and others—will follow this advice.

The Commission believes that a national system, as recommended by the National Council on Education Standards and Testing, should integrate assessment of proficiency in SCANS know-how with other equally important outcomes of schooling. Such a system is needed to:

- Communicate world-class standards of curriculum content and student performance, and
- Certify individual performance and thereby motivate students and their teachers to meet these standards.

The challenge is to design a system that clearly establishes that all young people in our nation have the right to an education up to a recognized performance standard—without putting the burden of failure on students' backs.

The Commission suggests establishing for all students, beginning in middle school, a cumulative résumé. The résumé would contain information about courses taken, projects completed, and proficiency levels attained in each competency. A student who accomplishes enough to meet an overall standard would be awarded a certificate of initial mastery (CIM), a universally recognized statement of experience and accomplishment. The information would mean the same thing to everybody: this person has the SCANS workplace know-how noted here.

Students would be free to use their résumés in seeking employment or further education at any time. Employers could be expected to demand from students the highest level of certification that the job demands (i.e., high-performance workplaces can demand high skills including, but not limited to, those required for the CIM). It would be up to the consumers of this information—employers, col-

[1] *Raising Standards on American Education* (Washington, D.C.: National Council on Education Standards and Testing, January 1992).

leges, the military, or others—to decide what weight to give each element in the résumé, using their own needs and criteria as guides.

In addition to the education-based assessment, a way to assess and certify persons who are already in the workforce (an experience-based assessment) is needed. The Federal Government, some private firms, and a coalition of trade associations in the hospitality industry have begun the hard work that will lead to the needed assessment tools.

## IMPROVING THE "LEARNING A LIVING" SYSTEM

The Commission understands that preparation for work is only part of the mission of schools, and that school is only part of the learning process. President Bush has spoken of the need for America to be a nation of learners and for the "education revolution" to extend beyond the schools into the community. This report is concerned with those parts of education and work that form the "learning a living" system.

In the learning-a-living system all students, at least through the second year of high school, learn the SCANS know-how in English, math, science, history, and geography, in other classes (e.g., art), and in extracurricular activities. That is, all students follow a common academic program, a single track, until they are about 16. After age 16, some students are more likely to be learning the SCANS know-how in the context of work, perhaps by specializing in the application of the competencies to a particular industry, such as manufacturing or hospitality.

Some of these students will go on to community colleges in a 2+2 tech-prep program, a program that begins with the last two years of high school and leads to an associate degree after two years of college. Other students will continue to learn the SCANS know-how in academic courses as they move toward a four-year college program. Others will, after graduating, go directly to work and work-based learning.

In addition to formal schooling, learning takes place through employers and work-based education. This learning should continue for a lifetime, supported by the human resource functions of recruiting, developing, and retaining employees. Workplace education produces portable certificates that are valued in many workplaces.

Information should flow from employers to educators through recruiting and employee development activities, including the ways in which employees progress up career ladders. Educators, in turn, should inform employers of the workplace competencies that students have attained. Today, neither employers nor educators receive or deliver information effectively. The SCANS aim is to improve the information flow (and the learning and earning) so that the economy will deliver the high productivity and wage increases that characterized the United States in the years from 1937 to 1973.

Exhibit 2 outlines the actions that are needed to reach the SCANS goals. Unless the

nation takes forceful action on this agenda, the nation's schools, employers, students, and workers will not fare well in the next century.

This, the SCANS final report, provides a blueprint for groups at the national, state, and local levels. Each community must decide what

## EXHIBIT 2

### RECOMMENDATIONS FOR THE "LEARNING A LIVING" SYSTEM

**THE COMMISSION RECOMMENDS FULL IMPLEMENTATION OF THE FOLLOWING ACTIONS BY THE YEAR 2000:**

Reinventing Schools

- Workplace know-how (the SCANS foundation and workplace competencies) should be taught along the entire continuum of education, from kindergarten through college.
- Every student should complete middle school (about age 14) with an introduction to workplace know-how.
- Every student by about age 16 should attain initial mastery of the SCANS know-how.
- Every student should complete high school sufficiently proficient in the SCANS know-how to earn a decent living.
- All federally funded programs for youth and adults, including vocational education programs, should teach the SCANS know-how.

Fostering Work-Based Learning

- Federal, state, and local agencies should incorporate SCANS workplace competencies into their own employee programs.
- Private-sector work-based training programs should incorporate training in the SCANS workplace competencies.
- Coalitions of businesses, associations, government employers, and labor organizations should teach the SCANS competencies to the current workforce, including employees of small businesses.

Reorganizing the Workplace

- The vast majority of employers should adopt the standards of quality and high performance that now characterize our most competitive companies.
- Firms should develop internal training programs to bring employees to the proficiency in the SCANS competencies needed for high-performance work organizations.

Restructuring Assessment

- A national education-based assessment system should be implemented that will permit educational institutions to certify the levels of the SCANS competencies that their students have achieved.
- Public and private employers should define requirements for higher-level competencies.
- Employment-based assessments should permit diagnoses of individual learning needs.

resources will be allocated to create a system that will meet its specific goals. But first, each must become involved in a conversation about its place in a fast-changing world as we approach the year 2000. Our nation's ability to lead in a global economy will depend on the outcome of those conversations. This Commission is confident that once they are informed, communities will commit themselves to maintaining the American dream for themselves and their children.