DOCUMENT RESUME

ED 258 608 JC 850 225

AUTHOR Gonzalez, Xavier F.; Waintraub, Jack
TITLE Program Requirements and Career Patterns concerning Technical Education.
PUB DATE 85
NOTE 14p.
PUB TYPE Guides - Non-Classroom Use (055) -- Reports - Descriptive (141)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Admission Criteria; Community Colleges; *Curriculum Development; Electronics; Electronic Technicians; Program Design; *Program Development; *Technical Education; Technical Institutes; *Technical Occupations; Two Year Colleges

ABSTRACT

This paper discusses program requirements and career patterns in technical education with the goal of assisting persons who design community college/technical institute programs to produce technicians to work in a technological environment. The first section describes the five components of the product development cycle in which technicians work and their role in each of these processes; i.e., research to discover new materials and processes; product development; manufacturing; marketing and sales; and installation, maintenance, and service. The second section explains the requirements and criteria for technical education and technician training programs, focusing on the role of mathematics education, microcomputers and microprocessors; and on program needs and requirements. The third section provides information concerning careers and program requirements in electronics, highlighting trends and changes within the field. The final section outlines entrance requirements for technician education and includes an overview of courses and programs required for students interested in the technician field. (HB)

Program Requirements and Career Patterns
concerning
Technical Education

by

Xavier F. Gonzalez, P.E.
County College of Morris
Randolph, New Jersey

and

Jack Waintraub, Chair
Electrical Engineering Technology
Middlesex County College
Edison, New Jersey

Charles R. Doty, Ph. D.
Editor
Department of Vocational Technical Education
Rutgers The State University of New Jersey

1985

This paper was written to assist persons designing programs in community colleges and technical institutes that produce technicians who will work in the technological environment. The first section introduces the reader to the product development cycle in which technicians work. The second section explains the requirements and criteria for technical education programs and training programs. The third section gives information for a specific technological area (electronics) concerning careers and program requirements. Last, for persons involved in advising future, potential students entrance requirements for technician education are described.

The Product Development Cycle

The product development cycle consists of five components: researching to discover new materials and processes, developing, manufacturing, marketing and selling, and installing, maintaining and, servicing. Technicians serve in each component of this cycle.

In the research component the technologist* works under the direction of a research engineer to measure and test materials and design fabrication processes. The materials andprocesses invented via research are then developed into a product. The development component involves technicians in various capacities, generally in prototyping the product through laboratory testing to adhieve quality assurance.

The developed product then is analyzed to design a manufacturing process. Technicians in manufacturing apply their knowledge of robotics, automated assembly lines, electronics, mechanic skills and quality control techniques.

Technicians at various points in a career are usually required to market and sell products in addition to theinstallation, testing, and maintenance of the products. Many service technicians, also referred to as service engineers or customer engineers, prefer sales functions and are a valuable input to themarketing of a product. The installation function is more mechanical and does not require the same level of skill and knowledge as those of maintenance.

---

* The term technologist means a person has a 4 year baccalaureate degree. A technician usually has a two year associate degree.

Requirements and Criteria for Technology Programs and Training Programs

A curriculum structured around fundamentals and core technology courses is preferred to one centered around training. Typically, in times of rapidly changing technology an individual's training may not endure the changes. Individuals may find it frustrating or even impossible to acquire the new skills needed to maintain themselves in the technology. A balanced program will provide the mathematics and science fundamentals, core technology and some specialization courses essential for maintenance of skills. Employers are generally reluctant to place persons with only vocational training in areas of responsibility which may use sophisticated equipment. This view is shared by others in the field. A group of technical educators and industrial representatives studying the manpower requirements of Ohio "...found that although the executives are supportive of vocational education, they do not view vocational education as a resource for training persons for high-technology positions. They want to employ technical education graduates of two year or four year colleges for these positions (McCormick, 1983).

Mathematics in the program should provide a solid background in algebra and trigonometry. Depending on the program emphasis, other mathematics courses should include calculus, for engineering technologies or statistics for manufacturing technologies. A minimum of one year of mathematics, exclusive of any developmental mathematics needed to correct student mathematic deficiencies, is highly recommended. A programming course in a higher level language (BASIC, FORTAIN, or Pascal) is a necessary part of any technology program. This programming course shouls be a technical problem solving course with students developing the solution algorithm and programming the computer.

Technical skills in microprocessors and microcomputers should be part of the technical program. However, a careful analysis of specific goals should be made before embarking on microcomputer and microprocessor technology as the center theme of a program. Specifically, microprocessor based systems are being designed with fault tolerance, and diagnostics that prior to the advent of the microprocessor would be unthinkable. Such designs require very little technical competence to be maintained in the field. Therefore, computer field service may not require the skill levels and command the salaries usually associated with technology level skills. However, there are critical skills in the area of microprocessor interfacing, networking, testing and programming essential in product development, board testing and manufacturing that should be a major consideration in a program.

Recently, there has been an emphasis to develop narrow two year technology programs in areas such as Microcomputers, Telecommunications, Robotics, Opto-Electronics. Unless there is an overwhelming industrial need in the local area, it is better to develop a general Electronics/Electrical Technology Program and provide options to the general program. This strategy provides the students with a flexible technical base for their careers and also facilitates institutional change as technical changes and local needs are redefined.

A critical ingredient in a program is the need to have instructors with the work experience in electronics/electrical engineering or technology. In two year college programs academic requirements should include a B.S. degree in the engineering or technology, Administrators should encourage faculty to maintain their skill in the technology and provide financial support for professional development. Outside work or consulting with local industries should be encouraged because such work provides an essential link between industry and the college.

Some criteria to develop two year level technology programs are:

1. The program should target an area of the electronics/electrical technology industrial spectrum. It is difficult to create a quality program that encompasses all aspects of the technology (product development, manufacturing and servicing).

2. Instructional staff should be competent in electronics, having suitable work experience in the targeted area. Academic qualification preferably should include a B.S. in engineering or technology.

3. An industrial advisory committee should be an operational part of the program from inception.

4. An Engineering Technology program should stress fundamentals in mathematics, science (Physics), and computer programming. Technology programs whose emphasis is manufacturing and repair can reduce or modify the mathematics and science courses to suit the level of the target technology.

5. Core electronics courses must provide hands on laboratories. The emphasis should be on interpretation of results, written communications of the experiment, and use of the equipment.

6. Course work and tests should be problem oriented. The level of the problems should be maintained at the level of the mathematics of the program.

7. Communication courses including technical writing should be included as part of the program and integrated into the laboratory reports.

8. Laboratory equipment should parallel that used in industry. The equipment learning sequence should progress from very basic equipment in the first term and gradually become more sophisticated.

9. Specialization courses in the last year should be directed to the most likely employment opportunities available in the local area.

10. Cooperative education could be used to supplement the areas of specialization, especially in areas where the equipment cost is prohibitive.

Training programs are typically one year or less and are characterized by their intense and specialized focus. Some criteria for developing such programs are as follows:

1. The program should target narrow areas of specialization. The length of the program must be analyzed for desired content and the level of the starting student.

2. The program should be developed in conjunction with local industrial needs, preferably this should directly involve specific companies.

3. Equipment used in training should emulate the task to be done in industry.

4. Only the essentials of the technology should be stressed. Much of the program is developed on 'how to' rather than 'why.' Problem solving is directly related to the topic and involves logic deduction rather than mathematic skills.

5. Instructors need to have industrial background in the area of specialization. Technical school graduates would, in most cases, possess adequate academic qualifications to instruct at this level.

Technical Careers in Electronics
and
Requirements for Electronics Associate Degree Programs

There are three options in technical careers in electronics that exist, Electrical Engineering Technology, Electronics Technology, and Electronics Manufacturing Technology, each requires different psychomotor skills and mathematics/science knowledge levels. Educational programs for preparing persons for these options have traditionally been single programs, i.e. all encompassing. However, trends in automation, computer aided design, and diagnostics are creating so large a body of knowledge that there is need for more specialized curricula. One comprehensive program cannot deliver the necessary education to prepare persons for all three options due to the constraints placed upon an associate degree program.

Electronics Engineering Technology

Electronic Engineering Technology curricula are typically two year college level programs. These programs, in general, provide transfer options into Baccalaureate Engineering Technology degree programs. Most graduates of Engineering Technology assist engineers in designing and testing new products. These programs have an algebra, trigonometry, and elementary calculus base.

It is imperative that Electronic Engineering Technology programs closely resemble the actual task to be required in the engineering laboratory. Engineering tasks are becoming more complex and the tools required to develop products are likewise more complex. The trend is to design new products by providing the initial design using computer aided analysis and modeling rather than making a series of prototypes and debugging them. The few prototypes made will still be debugged and modified by the engineering technician. At this point of the product development the technician will be involved with rather sophisticated testing equipment. The technician may also be responsible for some testing software, shcematic (CAD) modification and other computer level entries.

New programs in engineering technology should include digital electronics and microprocessor interfacing as part of the core. Digital courses should come early in the program to provide parallel analog and digital learning paths. Higher level computer programming should also be as early as possible. Computer application should be included in all core and as many of the specialization courses as is appropriate. Specialization and core courses should provide indepth coverage (with problem solving and laboratory reports) rather than trying to cover a multitude of topics. Specialization should heavily emphasize the equipment and procedures used to test and develop electronic products.

Electronics Technology

Electronics Technology curricula designed for servicing technicians vary from one year to two years. The programs, that are designed to meet the needs of the service segment of the electronics industry, should provide a well rounded but not necessarily indepth understanding of electronics, develop mechanical skills, and teach oral communication skills. The mathematics level should provide sufficient algebra and trigonometry to develop the understanding in the core electronics courses. Calculus is not required but statistics would be useful. Specialization courses should involve complete system troubleshooting strategies, mechanical disassembly and reassembly of equipment, and use of diagnostic aids and equipment. The program should also involve management courses which may focus on sales and service organization. Graduates of servicing type programs are typically placed in field repair, manufacturing representative, central repair, sales, and installation positions. Large market areas in which these positions occur are computers, computer peripheral, automated equipment, and consumer electronics.

Servicing of electronic equipment at the customers site is becoming less technical as more new products designed provide self diagnostics. The diagnostics identify the source of the problem, frequently with little human intervention. The main task of the field service technician is to bring the equipment 'up' [repair] as rapidly as possible. The technician should understand the equipment at a systems level and project this confidence to the customer. Additionally, field modification of equipment may be handled by field service technicians.

Technicians in central repair locations typically troubleshoot the failed unit found in the field and replace the failed components. Bench servicing technicians are typically equipped with dedicated test equipment, which to various degrees, guides the technician to the faulty component. Other tasks may include statistical failure, reporting modification of boards, and setting up guided fault analysis on the dedicated test equipment. Consumer electronics servicing in areas such as computers, video tape recorders, etc. is expanding but specialization courses stressing this area should specifically target the products.

Electronics Manufacturing Technology

An Electronic Manufacturing Technician's major involvement will be in installation, reconfiguring machines, maintenance, automatic testing and quality control. Curricula targeting electronic manufacturing technology should provide a broad background in electro-mechanical core. These core courses should include basic DC and AC, electrical machines, digital circuits, manufacturing processes and planning, mechanics and fluids. Computer programming courses involving higher level language such as BASIC and numerical machine control languages such as APT should be part of the core. Mathematics should provide applied algebra and trigonometry to support the core and specialized courses. An applied statistics course should also be included in the mathematics sequence. Specialization courses in electronic instrumentation, instrument and computer interfacing, process control and robotics should be part of the curriculum. Specialized curricula in robotics should be carefully evaluated relative to the local industrial needs.

Entrance Requirements for Technician Education

Career planning begins at an early stage in life. Although one can almost always switch careers, it is important that one does thorough planning during the early stages of high school concerning a career path. A high school student can prepare to receive career oriented training through choosing the proper high school course of study. Because technical education and training in the future will require a mathematical foundation as well as communication skills, it is important to plan high school courses which include those subjects.

The mathematics level required for entrance to a technology program is generally: Algebra I, Algebra II, and Plane Geometry. The knowledge of Algebra is a necessary tool in solving applied technology problems and understanding mathematical justifications. A background in Plane Geometry is useful for conceptualizing diagrammatic representations.

Communication skills, both written and oral, are of importance to the individual embarking on a technical career. The technician must be able to communicate with peers, as well as with laypeople who do not have technical knowledge. Good writing skills are necessary to present technical ideas in the form of a technical report or a general technical paper. Those skills are usually developed further at the post secondary level, but can be acquired in high school.

It is a common misconception among high school students, that if they are not interested in courses that stress reading and writing, that they should pursue a technical career rather than a career in the arts or social sciences. A technician spends a significant amount of time writing reports and preparing presentations. A service technician also interacts with the customer. A technician must have exceptional writing and verbal skills, and be skilled in human relations.

CAREER AWARENESS

High school guidance counselors are certainly primary contact persons for researching career paths. In addition to the various activities arranged at the high school, students should participate in both formal and informal programs offered through local colleges and universities, professional organizations, and special groups, such as the "Explorer" program offered by the Boy Scouts of America. The "Explorer" program provides career awareness by involving the participant in the daily activities of the professional.

Professional societies such as the P.E. (Professional Engineering) Society, the I.E.E.E. (Institute of Electrical and Electronics Engineers), and others are offering various programs on the local level to introduce high school students to the professions. Finally, students can contact local industrial firms, and arrange for visits and discussions with professional personnel to achieve a better awareness of theirpotential career choices.

References

McCormick, R. W. (April 1983). Vocational-technical education interface with Ohio's high technology business and industrial sectors. Columbus, Ohio: Ohio StateAdvisory Council for Vocational Education.