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ABSTRACT

A study, described in this report, was conducted to provide information to national vocational education policy makers regarding curriculum development needs for selected new and changing occupations. The report also outlines a methodology for identifying new and changing occupations and assessing the need for curriculum development. Information was collected by (1) identifying new and changing occupations through data analysis; monitoring legislative, economic, technologic, and social trends; and communication with professional associations, special interest groups, and knowledgeable persons; (2) collecting occupational information for designated career fields; (3) locating curricula, civilian and military, currently available for training people in the new and changing occupations; and (4) assessing the gaps between training needed for new and changing occupations and the available curricula. New occupations identified by these methods include the following: case manager for the mentally disabled; housing rehabilitation specialists; laser/electro-optics technician, tumor registrar; and occupations related to energy and microprocessing. Each of these occupations or occupational areas are analyzed according to functions, duties, and specifications; education and training requirements; employment outlook; employment setting; career advancement opportunities; available curriculum and progress; and implications for curriculum development. (KC)

CURRICULUM DEVELOPMENT NEEDS FOR VOCATIONAL EDUCATION: NEW AND CHANGING OCCUPATIONS

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FOREWORD

The need for more adequate information upon which to base policies, plans and priorities in vocational education is underscored in the Education Amendments of 1976. Technological advancements and changing societal demands present severe difficulties in designing and delivering vocational programs that meet present labor market needs and are responsive to future employment opportunities. One kind of necessary policy information consists of the needs for curriculum development in new and changing occupational areas. This report, developed by the National Center under its contract with the Bureau of Occupational and Adult Education, U.S. Office of Education, is a result of the second year of a continuing effort to provide such an analysis for national planners and policy makers.

The National Center expresses its appreciation to the many individuals who contributed to this report. Special thanks are extended to Mollie N. Orth, program assistant, and Jill Frymier Russell, program associate, who prepared this report, and to Edward J. Morrison who supervised the report's development and preparation.

We wish to thank our consultants for their guidance and willing assistance: Max Carey, Bureau of Labor Statistics; Pamela Crawford, East Central Curriculum Management Center; Maurice Roney, Texas State Technical Institute; and Jeff Windom, Virginia Occupational Information Coordinating Committee. A special thanks is extended to the consultants who developed papers for this report: John R. Doggette and Wayne Stevenson, Oak Ridge Associated Universities; and Charles Solomon, Texas State Technical Institute. James B. McCord, Western Iowa Community/Technical College; Robert E. Norton of the National Center; and John Van Zant, National Occupational Information Coordinating Committee, made valuable contributions in their critical reviews of the manuscript prior to final revision.

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CHAPTER I

INTRODUCTION

It is critical that vocational education respond to new and changing occupational areas. The 1976 Education Amendments require that vocational education give priority to programs for new and emerging occupations. Not only do employers need highly skilled individuals for production and service, but the young and others seeking employment want educational programs that will serve both in the present and future. Economists speculate that recent declines in American productivity may be a result of a lower standard of training in the labor force. Such factors require vocational education planners and administrators to respond to the emergence and growth of new occupational careers. Training and education provided through the vocational education system must correspond with current employment patterns to be effective.

Changing technology can cause new jobs and skill requirements to appear within the labor market very quickly. For example, within the last twenty-five years, jobs in the computer industry have expanded from a very few to almost 800,000 (Nelson, 1978). In addition, since 40 million Americans are in some stage of career transition, vocational education must be aware of and respond to these new and emerging occupations (College Board, 1978). However, because "new developments in technology may take as long as two years or more to be factored into existing vocational education programs" (Nickerson, 1978), vocational educators must actually anticipate the future in order to be prepared when it arrives.

Job preparation within schools must match employers' job requirements. Only a curriculum based on job descriptions; required skills, competencies, and aptitudes; employment conditions; and a realistic estimation of career opportunities will provide the needed knowledge and background to the student and future worker. The usual developmental process of a vocational curriculum begins with a task analysis. However, the traditional task analysis may be more difficult to complete for newer occupations. This is due to the small numbers of persons usually employed in emerging occupations and the often evolving nature of the field (Nelson, 1978). Therefore, the process of collecting information may need to be accomplished differently for new and emerging occupations as opposed to older, more established occupations.

Additional factors can influence curriculum development for new and changing occupations as opposed to long standing occupations. For example, technological advances, legislation, and changing social standards all affect the requirements for new skills and specialties. Nevertheless the same job may have different names, and tasks may vary according to the employing organization. Also, the development of curriculum for new vocational programs can be time consuming, for educators must often form or develop their own curriculum without an opportunity to review similar work by colleagues in other schools and colleges.

Vocational education, as an enterprise, needs to include preparation for new and changing occupations within its scope of activities. In order for this to happen a thorough description of the given occupation and matching personal competencies must be developed as input for curriculum design. For the reasons mentioned earlier, it may be necessary to develop this understanding about the new or changing occupation in a manner differently from that used for describing established occupations.

Purpose

The purpose of this report is to provide information to national vocational education policy makers regarding curriculum development needs for selected new and changing occupations. The report also outlines a methodology for identifying new and changing occupations and assessing the need for curriculum development. It is hoped the information will facilitate vocational education's responsiveness to changing employment patterns.

This report is the result of the second year of an ongoing research effort to determine curriculum development needs for new and changing occupations within vocational education. Funded by the United States Office of Education, Bureau of Occupational and Adult Education, the project provides information for planning and policy purposes on both methodologies appropriate for assessment and actual areas of need.

Process

The information being provided within this report has been collected by--

1. identifying new and changing occupations through data analysis, the monitoring of legislative, economic, technologic, and social trends, and communication with professional associations, special interest groups and knowledgeable individuals;

2. collecting occupational information for designated career fields (job descriptions, skills and aptitude requirements, preferred training levels, employer information, and career opportunities);

3. locating curricula, civilian and military, currently available for training people in the new and changing occupations; and

4. assessing the gaps between training needed for new and changing occupations and the available curricula.

Scope

In order to implement this study of curriculum development needs for new and changing occupations it was necessary to establish the parameters of the research. The definition of critical terms impacts upon the scope of the project. Those terms are--

vocational education;
new and changing occupations;
curriculum; and
occupational information needs.

For the purposes of this study, "vocational education" was defined as training for an occupation taking place at the secondary, postsecondary, or adult level exclusive of professional training which requires a baccalaureate or professional degree. A further restriction applied for this project defined vocational education as requiring a minimum of two months for upgrading or six months for new trainees and includes any nonprofessional program at a level less than four year colleges.

The need for curriculum development within vocational education is limited in this study to "new and changing occupations."

These career fields are ones in which there is national demand, that have become identifiable in the past decade, and that have developed as a result of: (a) the creation of new industries or occupations (for example, the computer industry); (b) a significant restructuring of existing occupations (for example, physician's assistants); and (c) modifications of required skills in existing occupations (for example, word processing) (Forgione, 1978).

This study defines a "curriculum" as: those materials which delineate learning objectives, topical outline, content, and methodology of a formal instructional course or series of courses. The materials, whether written or visual, must be organized so that they can be transported, i.e., adopted or adapted for use by others.

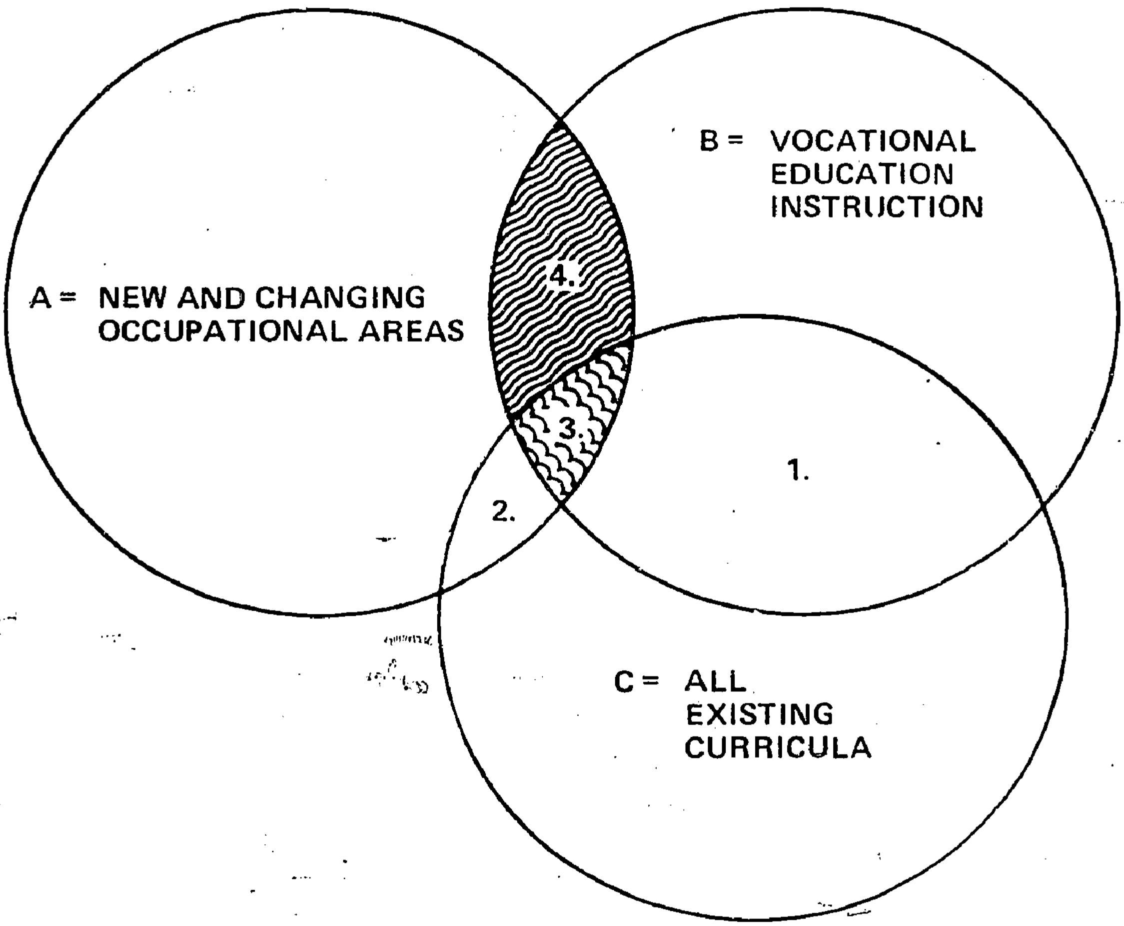
"Job information needs" relevant to this study are data and descriptions of :

- job duties
- skill and aptitude requirements
- wages and hours
- barriers and constraints (licensure, physical capabilities, special equipment)
- education and training requirements
- employment outlook (projections regarding growth and expansion needs)
- typical employer product or service
- usual recruiting and hiring process
- present source of workers
- related occupations and/or transferable skill area
- career ladder possibilities

Figure 1, "Identifying Needs for Curriculum Development in Vocational Education for New and Changing Occupational Areas," models the scope of this project.

Figure 1

Identifying Needs for Curriculum Development in Vocational Education for New and Changing Occupational Areas



Key

1. Existing curricula for established occupational areas that fall within the scope of vocational education instruction.

2. Existing curricula for new and changing occupational areas that do *not* fall within the scope of vocational education instruction.

3. Existing curricula for new and changing occupational areas that fall within the scope of vocational education instruction.

4. New and changing occupational areas that fall within the scope of vocational education instruction but for which *no adequate curricula exist.*

References

Forgione, Pascal D. Jr., and Kopp, A. Lee. Curriculum Development Needs for Vocational Education: New and Changing Occupational Areas. Columbus: The National Center for Research in Vocational Education, 1979.

Forty Million Americans in Career Transition. New York: The College Board, 1978.

Nelson, Orville. "Emerging Occupations." The Wisconsin Vocational Educator. 4 (1978): 1-3.

Nickerson, Bruce E. "Vocational Education for a Changing Marketplace." The Wisconsin Vocational Educator. 4 (1978): 5-7.

CHAPTER II

METHODOLOGY

Provision of information to BOAE/USOE on national curriculum development needs in new and changing career fields was accomplished by this project through a four stage process--

1. the identification of new and changing occupations;

2. the collection of information on the identified occupations;

3. the location of curricula and program offerings that prepare individuals for the identified occupations; and

4. the assessment of need for the development of curriculum for the identified occupations.

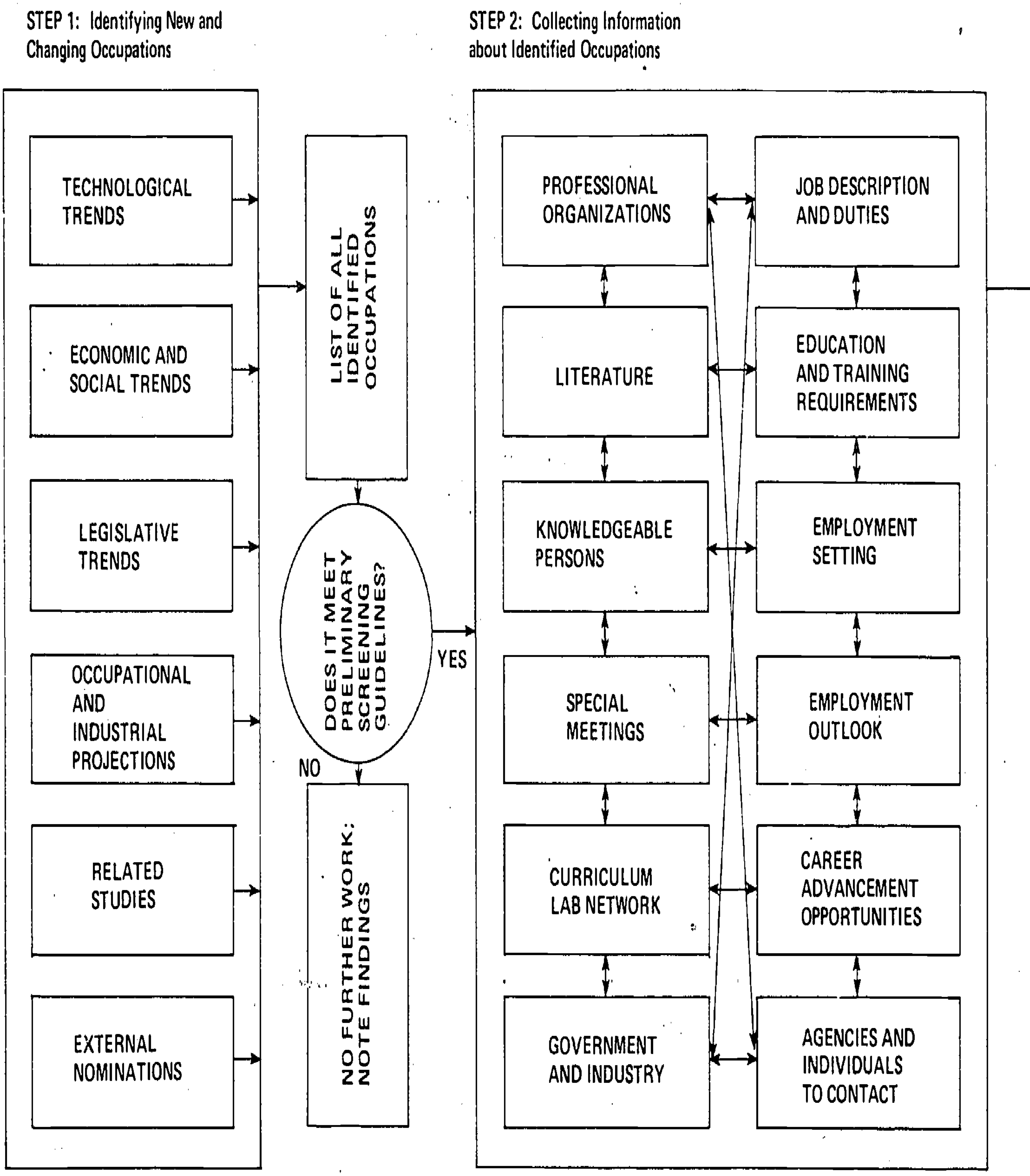
Due to the nature of the contract through which this study was funded, no new data were generated; only available data and information were used. The methodology reflects this approach with its emphasis on extant sources.

Figure 2, "Flowchart of Methodology," demonstrates the flow of events for achieving the four step process.

Identifying New and Changing Occupations

In order to identify new and changing occupations, this study reviewed several types of information. In a collaborative manner with the Alternative Futures of Vocational Education project at the National Center, the project monitored trends that affected occupations in order to determine the implications for careers. Occupation and industry projections for change and growth were examined. Literature and other studies relating to new and changing occupations provided suggestions for areas that needed further study. Finally, external sources such as professional associations were asked to nominate new and changing occupations.

FIGURE 2 METHODOLOGY FOR IDENTIFYING NEW AND CHANGING OCCUPATIONS WITH A CURRICULUM DEVELOPMENT NEED



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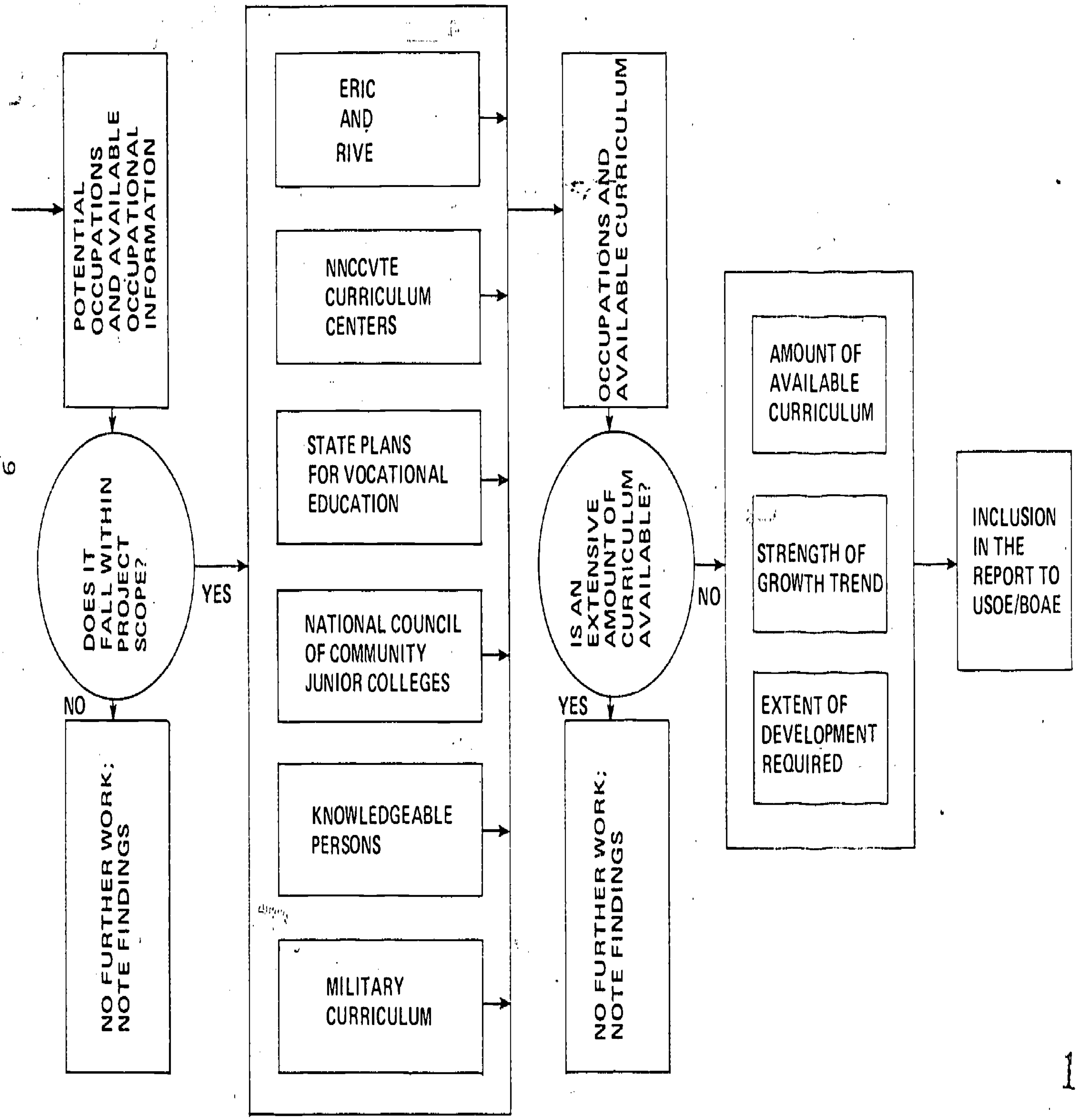
STEP 3: Locating Available Curriculum

STEP 4: Assessing the Need for Curriculum Development



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Trends

Technologic, legislative, social, and economic trends and developments can and do affect occupations and jobs. In order to pinpoint such information, a computerized literature search for materials that dealt with trends in occupations was conducted. In addition, the Alternative Futures at the National Center concerned with the futures for vocational education provided input on futures projections concerning occupational change.

For example, futures literature indicates that there will be rapid changes in technology, particularly in lasers, that may affect occupations. Also, economic trends have impacted upon energy and construction costs making housing rehabilitation in inner cities more desirable. Moreover, funds for such rehabilitation have tripled in recent years. Occupations in the fields of lasers and rehabilitation have therefore been affected by trends and developments in technology and the economy.

Occupational and Industrial Projections

Growth or changes in the traditional labor market affect the growth and change of new occupations. This study reviewed and considered the Bureau of Labor Statistics' (BLS) unpublished projections of occupations by industry for the period of 1976 to 1985 in order to identify new and changing occupations. Available industrial or organizational (professional association) projections for specific occupations were also considered in the process of determining occupations needing further study.

BLS occupational projections deal primarily with existing occupations. The data regarding occupational areas did prove to be helpful, however. If an occupational area (or in some cases an occupation) projected significant growth from 1976-1985, then additional research was conducted to determine if a new occupation was developing. For example, science technician engineers showed a 21 percent growth from 1976 to 1985, with subcategories showing even higher growth. Professional organizations in related areas were contacted next for additional information, resulting in the occupation of instrumentation technician being considered.

Related Studies

Related studies including Drewes, et al. 1978; Lecht 1976; and Meleen, et al. 1976 were reviewed for new and changing occupations. Occupations once considered "too new" for curriculum development were reinvestigated. An example of this was the microprocessing technician mentioned in Planning for Vocational Education: New and Emerging Occupations (Meleen, 1976). At the time of publication the authors felt the microprocessing industry was too new to be fully assessed for occupational implications.

Occupations studied in earlier projects were reexamined to see if existing curricula needs updating in order to remain relevant. According to Arthur H. Nelson and Allen Parker of the Technical Education Research Center (TERC)

> In the case of emerging technical occupations, such changes may be necessary every year or two for many years until an occupation becomes well-defined. New occupations are also likely to have manpower needs which increase for decades before becoming stabilized; consequently, additional educational programs must be established each year for some length of time. (Nelson and Parker, 1974)

External Nomination

Organizations and agencies that might possess information regarding new or changing occupations were contacted early in the study. These contacts included the National Network for Curriculum Coordination Centers in Vocational/Technical Education (NNCCVTE) and state liaison representatives, Department of Labor occupational analysis field centers, the National Council of State Directors of Community and Junior Colleges, regional and state level Industry-Education-Labor coordinators, State Occupational Information Coordinating Committee (SOICC) directors, and occupational employment statistics (OES) survey states.

In many cases, "nominated" occupations had either been identified in other reports or were under investigation. A few new or changing occupations were related to specific regions or states and therefore were not considered of national significance for the present time.

Examples of such regional occupations are Alaskan occupations related to "bottom fishing." Public Law 94-265, effective March 1, 1977, created a 200 mile limit for the Fishery Management Authority and thus made a bottomfish industry feasible in Alaska and elsewhere. The new industry has created new occupations with different skills and has brought about a significant restructuring of the existing fishing industry, especially in relation to equipment adaption and facility use.

Preliminary Identification

The project compiled a listing of the occupations identified by the review of trends, projections, related studies, and external nomination. (A complete list of the occupations appears in Appendix B.) The objective was to develop a comprehensive listing of new or changing occupations.

The project staff then screened these occupations on the basis of general guidelines, but felt that no final decision on the acceptance or elimination of occupations could be made until completion of Steps II and III of the methodology. It was necessary to eliminate those occupations that did not fit the parameters of the project.

Established occupations. Established occupations, in existence for more than ten years, were not considered for further review. This is not to say that they might not need further curriculum development, but the target of this report is new or changing occupations. The project did review established occupations with high projected growth rates to 1985 in order to examine the possibility that new occupations might be created.

National Center Year I occupations. Occupations (particularly in health) noted in the first National Center report on new and changing occupations (Forgione and Kopp, 1979) or a related National Center report on the feasibility of converting military curricula (Forgione and Orth, 1979) were not restudied this year. (The only exceptions are the Solar Mechanic and Solar Technician occupations. There is still some question as to needs for curriculum development here.)

Occupations with job analysis or curriculum development recently completed or currently underway. In a number of cases, organizations nominated occupations for which they are currently performing job analysis or curriculum development. If an occupation were undergoing job analysis, the project staff removed it from further study in this project year. The feeling was that completed task analysis would facilitate determination of curriculum development needs in the future and that if curriculum development were underway in a given occupation, other occupations should be reviewed first.

Occupations with insufficient demand. Occupations identified in related studies as having insufficient demand for labor force participants were set aside and given a lower priority for review by this project.

Occupations with nonvocational education requirements. Those occupations identified as having educational requirements of less than two months or a baccalaureate degree or higher were also set aside. If the educational requirements varied or were unclear, the project staff attempted to obtain additional information before reaching a decision.

As a result of these general guidelines the project filtered out a number of occupations, but a substantial number of potential new or changing occupations remained. To reemphasize a point, the objective aimed only to remove those occupations that lay outside the project's parameters in order to provide more time and effort to obtain information about potential occupations. The project staff then proceeded to Step II of the methodology.

Collecting Information About the Identified Occupations

Orville Nelson, in discussing emerging occupations, stated a primary consideration for vocational education:

> Vocational and technical programs are designed to prepare people for employment. These programs serve the needs of employers by providing skilled employees and serve the needs of students by providing opportunities for them to develop competencies which make them employable. Most vocational curriculum development systems are based on analyzing students' needs and labor market demand. (Nelson, 1978)

In order to develop vocational training programs beneficial to students and the community, one must assemble basic information on each new or changing career field. Whenever possible, occupational areas should be probed for answers to questions such as the following:

1. Will these occupations require completely new skills, an alteration of existing skills, or new combinations of existing skills?

2. Will the new or changing technical positions require totally new curricula or just the introduction of new courses within existing curricula? Or will the emerging employment areas require simply a revised combination of existing courses?

3. How many of the new and changing technical jobs have, or are likely to have, constraints to entry into the field (that is, control over entry by union or professional association or control of certification by government or trade association)?

4. What are the probable sources of training for the new or changing jobs? In particular, how much of the training will be gained by informal on-the-job training and by formal in-company, union, or trade association programs?

5. Will the demand for the technical occupations occur at the national level, at the regional level, and/or at the local level?

6. Will the demand continue over time or is it likely to be a one-time employment need? (Dogette and Blair, 1978)

The process of identifying and studying new and changing occupations is dynamic in that it is necessary to move back and forth between Steps I and II of the methodology. That is, following preliminary identification of a new and changing occupation, data must be collected to determine final selection.

The types of information required follow:

A. Job description and duties
   1. Alternative job titles
   2. Job description
   3. Job duties
   4. Wages and hours
   5. Barriers and constraints

B. Education and training requirements
   1. Degree or certificate program
   2. Apprenticeship program
   3. On-the-job training
   4. Professional standards

C. Employment outlook
   1. Expansion
   2. Replacement
   3. Future projections
   4. Geographic factors

D. Employment settings
   1. Industry
   2. Product or service
   3. Size of typical employer
   4. Usual recruitment and hiring practices

E. Career opportunities
   1. Present source of workers
   2. Career ladder possibilities
   3. Transferable skill areas

F. Agencies and individuals knowledgeable about the occupation
   1. Professional associations
   2. Reknowned experts
   3. Government agencies
   4. Colleges and universities
   5. Employers

The above information was collected by various means. The project contacted professional associations, individuals in colleges and universities, and employers who had been identified as knowledgeable in the field, by telephone and letter for their aid in describing selected occupations. Staff also examined descriptive literature and consulted The Dictionary of Occupational Titles to research information available on occupations related to the identified new and changing career fields.

A major addition to the methodology, not used in Year I, was telephone contact. Once an occupation was identified, telephone contact was made with professional organizations, schools, or employers. This technique proved invaluable in obtaining information about an occupation. However, a considerable drawback was the time and frustration involved. One occupation required seventeen calls before locating a person with background information. In most cases, however, contacts proved informative and eager, and their information was often more current than that obtained in the literature. Due to the nature of the occupations examined, desired job information was not always available or confirmable from more than one source.

Midway through the project year, the National Center invited consultants to review the tentatively selected occupations, related occupational information, and sources of available curriculum. The consultants felt that the methodology was sound and the occupations identified were acceptable and had no additional sources of information about occupations or curriculum.

Locating Available Curricula and Program Offerings

In order to locate existing curricula or program offerings for those occupations identified as new and changing, the staff completed a multifaceted search. This process involved: (1) a computerized retrospective search of journals, articles, and books, (2) a computer search of the ERIC Clearinghouse of Adult, Career and Vocational Education, (3) a computer search of the Resources in Vocational Education (RIVE) file, (formerly called AIM/ARM), (4) a review of federally funded projects in progress, (5) a request that National Network for Curriculum Coordination in Vocational and Technical Education (NNCCVTE) directors identify related curriculum and program offerings, (6) a request that state directors of the National Council of Community/Junior Colleges identify related curricula and program offerings, (7) a review of program offerings in the armed forces educational catalogues, and (8) a review of references to curriculum development and program involvement in state plans for vocational education.

The above sources were checked for existing curricula because the project staff felt that instructors, administrators, counselors, etc. have access to such information sources and the curriculum could probably be obtained at reasonable cost. Probably some form of curriculum exists for each occupation since the occupation itself exists. But a curriculum has limited value if it is not transportable and cannot be used by others. Therefore, curriculum availability in the listed sources plays a major role in the determination of developmental needs, Step IV of the methodology.

Assessing the Need for Curriculum Development

Curriculum development is a costly and time-consuming venture that contains some risks. The actual decision concerning adequacy of curriculum in a given occupation is subjective. For new and changing occupations, it represents a process individualized to specific occupations and available information. The project staff identified three areas of consideration that could be examined with existing data and that would facilitate the decision-making process.

Amount of Available Curriculum

The project was not in a position to acquire or evaluate non-military curricula. Therefore, an assessment by project staff of the quality of existing curricula was not possible. Curriculum comprehensiveness could only be surmised by the number of courses or programs available. The consultants at the mid-year meeting suggested an arbitrary figure of twenty programs. As it turned out, the figure was not necessary to determine the curriculum development need for a given occupation. Generally, occupations identified all had considerably fewer than twenty programs.

Strength of the Growth Trend

Another consideration lay in the stability of the occupation: will the demand for trained personnel continue or will it decline over a period of time? If the occupation is short-term then perhaps on-the-job training could satisfy curriculum needs and an extensive development effort would not be cost-effective. However, if the occupation is predicted to exist in the future then the growth rate may influence priorities for curriculum development.

Extent of Curriculum Development Required

Where possible, the extent of curriculum development required for given occupations was determined. This information was based on the judgment of knowledgeable persons working, teaching or developing curriculum in the occupation or related occupational areas. The project staff found that the range of curriculum development varied along a continuum from reorganization of existing curriculum to development of entire curriculum for a new program.

Limitations of the Study

In the past occupations came into being more slowly than at the present. Since World War II, American society has experienced a greater rate of change. This quicker pace has affected occupational emergence and growth also. New ways of examining change in occupations are currently being developed. This study represents one effort of educators to be responsive to that change. However, the methodology is evolving also. There are limitations in the state of the art of futures projections and occupational projections. The limitations of this study of curriculum development needs for new and changing occupations are in three primary areas--

1. the nature of the job;

2. the available information; and

3. the curriculum.

The evolving nature of new and changing occupations inherently implies a nonstatic situation. The status quo regarding employment needs or education requirements may vary significantly from year to year until some leveling off occurs. Collecting and reporting information on a changing phenomenon is risky and difficult. Trends in society, the economy, or legislation are difficult to predict also. Yet these factors affect occupational patterns and growth tremendously. The changes in new occupations are reflected by the fact that different sources of information have different views of the situation.

The sources of information about new and changing jobs may be more biased than those for established jobs. Since the Bureau of Labor Statistics makes occupational and industrial projections on the basis of past trend extrapolations, they cannot at present project growth for new occupations or older occupations which may change due to new technology. Therefore, the sources of information about new and changing occupations are professional association leaders, employers, and educators. These individuals may be biased. Their judgements can be subjective, but the information they provide may be the only information available; and because of their closeness to the field, these experts can provide valuable input.

Another limitation in the methodology of this study is due to the fact that curriculum is developed at all levels of the educational system; by teachers, schools, local education agencies, states, and the federal government. This plurality is usually desired; however, accessibility becomes a problem. Locating curricula is not an easy task; and one can never be sure all have been identified. In addition, assessing the quality of curricula that have been located is necessary, although not within the scope of this study. Therefore, if one excellent curriculum for a new and changing occupation exists but is not located, the actual need for curriculum development may be concluded incorrectly.

References

Doggette, John R., and Blair, L.M. "Emerging Energy Technician Occupations." American Technical Education Association Journal, November-December, 1978.

Dictionary of Occupational Titles. 4th ed. Washington, D.C.: U.S. Department of Labor, Employment and Training Administration, 1977.

Drewes, D.W.; Spetz, Sally H.; Heath, Walter D.; and Katz, Douglas S. Current and Future Employment Opportunities in New and Emerging Occupations within Illinois. Raleigh: CONSERVA, Incorporated, 1978.

Forgione, Pascal D., Jr., and Kopp, A. Lee. Curriculum Needs for Vocational Education: New and Changing Occupational Areas. Columbus: The National Center for Research in Vocational Education, January, 1979.

Forgione, Pascal D., Jr., and Orth, Mollie N. Department of Defense Curricula: Information Concerning Conversion for Civilian Use. Columbus: The National Center for Research in Vocational Education, January, 1979.

Lecht, Leonard A.; Matland, Marc; and Rosen, Richard. Changes in Occupational Characteristics: Planning Ahead for the 1980's. New York: The Conference Board, Inc., 1976.

Meleen, P.S.; Gordon, A.K.; Livesay, S.; Donovan, J.; Shuchat, J.; and Bloom S. Planning for Vocational Education: New and Emerging Occupations. Belmont: Contract Research Corporation, 1976.

Nelson, Arthur H. and Parker, Allen. "Program Development for New and Emerging Occupations." Journal of Research and Development in Education; 7; no. 3: 65-79.

Nelson, Orville. "Emerging Occupations." The Wisconsin Vocational Educator. 4 (1978): 1-3.

CHAPTER III

RESULTS

This chapter presents the results of the examination of national curriculum development needs for new and changing occupations within vocational education. Although there may be other occupations which require curriculum development, the occupations presented herein appeared most pressing.

This investigation began by considering a number of occupations (see Appendix B). However, as occupational information was collected and definitions of "new and changing" and "vocational education" were applied, fewer occupations fell within the parameters of the project. Another criterion which eliminated some occupations was the national scope of the project. Some occupations were relevant only at a regional, state, or local level. In those cases a local or statewide curriculum development effort would be more feasible.

The occupations and occupational areas listed below have some degree of need for curriculum development on a national basis:

Specific Occupational Titles
- Case Manager for the Mentally Disabled
- Housing Rehabilitation Specialist
- Laser Electro/Optics Technician
- Tumor Registrar

Industry Related Occupational Areas
- Energy Related Occupations
- Microprocessing Related Occupations

The two industry related occupational areas presented in this report were written by consultants due to the technical nature of the occupations and the need for more in-depth information about the curriculum development required. Some points to consider when reviewing those occupational findings are discussed in the following paragraphs.

The current energy shortages have intensified the need for accurate information on job creation and curriculum development needs for energy related occupations. The energy occupations' paper is intended to be comprehensive and deliberately discusses occupations which need curriculum development as well as occupations for which adequate curriculum exists.

The implications of the use of microprocessors for any mechanical and control equipment, as well as other applications, are immense. But the implications for employment as a microprocessor technician or the need for curriculum development are more difficult to anticipate. National data on this occupation are not available. The competition among microprocessor-related industries is fierce and secrecy is a major consideration. The project staff felt it was important to include the data which were available even though they are limited to one state.

The remainder of this chapter will explore each career field in depth and clarify the type of curriculum development needed.

CASE MANAGER FOR THE MENTALLY DISABLED

Case Manager for the Mentally Disabled

Case managers for mentally disabled in the community oversee and coordinate services for their clients. They periodically check on the persons they serve to ensure that they have adequate housing, food, transportation, and other basic necessities. According to a staff member of the National Institute of Mental Health, "It seems to be generally recognized in the field that case management is necessary because of the nature of the broad range of needs of this population" (Ben-Dashan, 1979).

Alternative job titles for case managers include service coordinators, case workers, case coordinators, and case aides. A "case" refers to the individual client; and case management, per se, implies doing something "to" (as opposed to "with") the client to better the client's life. However, service provision for the mentally disabled is changing and designers of case management systems now stress involvement of the individuals being served in the planning of their own services. Because of these philosophical differences, job titles and emphasis may vary considerably.

Functions, Duties, and Specifications

The primary activities of a case manager include:

1. Assessment of individual needs
2. Location of services to meet those needs
3. Coordination of services on an on-going basis
4. Provision of guidance to individuals on problem solving (Dean, 1979)

Another way of describing the duties of a case manager is to delineate the functions of the case management system: outreach, intake, assessment, planning, follow-up, referral, coordination, quality control, and evaluation (Smith, 1979).

By helping clients to help themselves, case managers train clients' families to act as their own advocates. The ability to provide clients with dignity and to allow them to make mistakes while learning is necessary for good case managers.

Additional prerequisites include maturity, patience, ability to deal with stress and ambiguity, and a willingness to work with the client in his or her own environment.

As important as what case managers do is what they do <u>not</u> do. They do not, themselves, provide all services needed by their clients. That is, if the client has need of serious counseling, the case manager only helps obtain counseling from appropriate sources. They do not provide counseling themselves. This interpretation varies from the traditional social work model of case management in which the professional often provides all the services.

Education and Training

Most experts consulted felt that a two-year postsecondary program is appropriate for case managers. In many instances, case managers will work with other professionals who care for the disabled person, so that their functions (overseeing and service coordination) do not necessitate baccalaureate or professional level training.

The following types of knowledge and skills are required for case managers:

1. Normalization theory

2. Needs and capabilities of the population

3. Working with social service agency people from other organizations (group process, negotiation, delivery systems, organizational development)

4. Working with the population (either mentally ill or developmentally disabled or both)

5. Behavioral and measurable objectives

6. Evaluation techniques for monitoring the clients progress

7. General philosophy of working with people to help them develop their own capabilities (Kahn, 1979)

Employment Outlook

Little has been accomplished in projecting labor force requirements for paraprofessionals within mental health and retardation fields. However, some data are available on those who may need case managers. Nationally, the institutionalized mentally ill patient load has dropped from 559,000 residents in 1955 to 215,500 in 1974 (Lechowich, 1979), despite population growth.

Deinstitutionalization has been legislated in many states and many who have lived in institutions for twenty years have been moved into the community. Clients now stay in institutions for shorter periods of time. But the number of persons who are mentally ill has not decreased. Patients now live in the community and in many cases are doing poorly because of limited abilities to cope and survive.

The situation is similar with the mentally retarded. A recent survey in Ohio found that approximately 110,000 people in the state are mentally retarded. Yet, 70,000 of those received no care, either institutional or within the community (Allen, 1978).

In order to afford the cost of serving this population, maximum use of services for the general population must be attained. A case manager can best accomplish this service coordination effort.

The need for case managers is great, but funding is questionable. However, the Mental Health Systems Act before Congress in 1979 specified case management of the mentally ill as an essential service. The Rehabilitation Services Administration is also examining case management in-depth. The trend toward use of case managers to facilitate service provision to the mentally disabled in the community is growing.

Employment Setting

Case managers may be employed in mental health centers or work out of institutions. They work in agencies for the developmentally disabled, welfare offices, or family service organizations. In most cases actual employing organizations would be determined by service delivery systems in a given community and the funding patterns in the state.

Career Advancement Opportunities

Career opportunities for case managers could include promotion to supervisory or administrative levels, or advancement to teacher, social worker, or psychologist after obtaining further credentials.

Available Curriculum and Programs

Professional opinion, confirmed by a computerized library search, shows that there are few curricula available for use in training case managers for the mentally disabled.

However, numerous educational programs operate throughout the country to prepare graduates for work as Mental Health Technicians or Mental Retardation Professional Associates. Faculty in these programs often develop their own curriculum. Although some of the content could be applicable, these Mental Health or Social Service Technology offerings are not directed towards the tasks of case managers. Some social service organizations which employ case managers also develop programs for orientation and inservice staff development. However, in general there is little in the way of specific curricula available to prepare case managers to work with mentally retarded persons in the community.

Implications for Curriculum Development

Although it is difficult to project future needs for case managers for the mentally disabled, the trend towards use of case managers in community-based services is growing. The need will not lessen unless institutionalization as a service mode regains wide use. This is not expected. Few training opportunities currently exist for preparation of case managers, nor are materials readily available. Thus, a curriculum development and adaptation need exists for preparing case managers to help the mentally disabled.

References

Allen, John, and Barker, Bruce. Prevalence of Developmental Disabilities in Ohio. Columbus, Ohio: Ohio Developmental Disabilities Planning Council, 1978.

Lechowich, Tom. A Tale of Two Systems: The After Care System in Ohio. Columbus, Ohio: Ohio Department of Mental Health, Mental Retardation, 1979.

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HOUSING REHABILITATION
SPECIALIST

Housing Rehabilitation Specialist

A housing rehabilitation specialist assists buyers, sellers, and lending institutions in rehabilitating or renovating housing, often within the inner-city.

Functions, Duties, and Specifications

Job duties of housing rehabilitation specialists comprise two major areas: administration (financial) and construction. In fact, the job may involve two positions. The administrative side entails performing credit checks, verifying employment, advising as to loan availability, and otherwise helping the buyer to apply for a loan. The construction component includes the preparation of cost estimates, plans for remodeling, project inspections, supervision of construction and authorization of payment to contractors.

Most positions are full time. Special skills and aptitudes which are required include: for the construction component - an understanding of techniques and methods to compute cost estimates, a background in building regulations and zoning, and the capacity to draw up and interpret construction plans; for the administrative component - a knowledge of financing and real estate, and the ability to assess individual eligibility for loans.

Education and Training Requirements

According to the National Association of Housing and Redevelopment Officials, preferred training for housing rehabilitation specialists includes blueprint reading and drafting; experience as a general contractor; two years of college level work in business administration, real estate, or sociology; and two years experience in real estate mortgage financing or credit evaluation.

If the job duties of the housing rehabilitation specialist are separated into two jobs (i.e., a construction and a financial component) the training required would be assigned accordingly.

Employment Outlook

Employment opportunities for housing rehabilitation specialists will grow as urban renewal grows. With increasing transportation and new construction costs, the cost effectiveness of the renovation of older buildings becomes more viable. Funds for housing rehabilitation loans have tripled in recent years, and the demand for specialists to administer rehabilitation efforts will very likely increase proportionately.

Employment Setting

Employment for housing rehabilitation specialists is found primarily in municipal offices that direct rehabilitation loan programs, although private organizations also employ a proportion of such specialists.

Career Advancement Opportunities

Based on expertise it would be possible for a rehabilitation specialist to advance to chief rehabilitation specialist in charge of either financial or construction activities. A rehabilitation specialist could also be promoted, for example, to supervisor of the housing rehabilitation section of city planning.

Available Curriculum and Programs

There is a limited number of materials that deal specifically with the occupation of housing rehabilitation specialist. There is, however, an extensive number of related materials and programs in the areas of finance and construction. These were identified by the NNCCVTE network and the National Council of State Directors of Community/Junior Colleges. The National Association of Housing and Redevelopment Officials (NAHRO) has developed a workshop on housing rehabilitation specialists and is in the process of developing standards for the occupation.

Implications for Curriculum Development

Funding for housing rehabilitation should continue in the future, and the need for trained specialists will increase. Depending on standards developed by NAHRO, it may be possible to combine existing curricula, with minor modifications, into a new program for housing rehabilitation specialists.

References

Benitez, A. William. Housing Rehabilitation: A Guidebook for Municipal Programs. Publication No. N580. Washington, D.C.: National Association of Housing and Redevelopment Officials, 1976.

Drewes, D.W.; Spetz, Sally H.; Heath, Walter D.; and Katz, Douglas S. Current and Future Employment Opportunities in New and Emerging Occupations within Illinois. Raleigh: CONSERVA, Incorporated, 1978.

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LASER/ELECTRO-OPTICS
TECHNICIAN

Laser/Electro-Optics Technician

A laser is a device that converts electrical power into a narrowly focused beam of light. Since its discovery in 1960, the use of lasers has greatly expanded. One of the first lasers, the pulsed ruby system, was used by the Western Electric Co. from 1965 to 1978 to drill small holes in diamonds which were then used as dies for drawing wire. This system has already been donated to the Smithsonian Institution's Museum of History and Technology (Laser Focus, June 1979). Today lasers have many industrial applications, including their use in conjunction with optical fibers by Bell Telephone Co.

> Since infrared light vibrates thousands to millions of times faster than microwaves or radio waves, it can accommodate more information than either. In practice, the sound waves are converted to an electrical signal, which is encoded and transmitted as light pulses. (Boraiko, 1979)

Functions, Duties and Specifications

Functions of the laser/electro-optics technician (LEOT) vary with the industry in which the technician is employed. Lasers are currently used in medicine, construction, the military, surveying, non-destructive testing, machining and materials processing, data processing, energy research, and communications.

A laser/electro-optics technician fabricates, troubleshoots and repairs both optical and electrical parts of laser systems, as well as assists in the design of experiments and the collection of data. The technician also operates most optical instruments, including spectrophotometers, interferometers and modulators (Laser Focus, May 1979).

There are two basic levels of LEOT:

1. As technicians who use one form of laser and perform a routine operation, i.e., maintenance welding

2. As research technicians who work with physicists and engineers performing experiments, and recording data, and acting as the eyes and hands of the scientist (Winburn, 1979)

With assistance from a national advisory council made up of members of business, industry, labor and education, the Technical Education Research Center (TERC) in Waco, Texas developed a list of tasks performed by laser/electro-optics technicians. The fifteen "most desirable skills" are listed below:

1. Troubleshoot and repair laser systems
2. Perform tests and measurements using electronic devises
3. Perform alignment procedures on optical systems, especially those involving lasers and related optics
4. Prepare and read shop drawings and schematics
5. Maintain a laboratory notebook, perform data reduction, and prepare reports
6. Operate interferometers, spectrometers, monochromators, and spectrophotometers
7. Operate laser systems, including intra-cavity modulation and Q-switching devices
8. Utilize basic laser and electrical safety practices in the laboratory
9. Perform optical inspections and cleaning of optical components
10. Operate and calibrate photodetectors, photomultipliers, optical power meters and calorimeters
11. Process photographic film and plates
12. Produce and reconstruct holograms
13. Select laser and optical components based on optical, electronic and mechanical properties using manufacturers' catalogues and other trade publications
14. Troubleshoot and repair electro-optics devices
15. Fabricate and assemble components for laser/electro-optic devices and systems (TERC, 1976)

Education and Training Requirements

The type of training required for LEOTS depends on the type of technician needed. Some fields are industry-oriented while others have research centers that require a higher skill level. Because of shortages of technicians in industrial areas, students are frequently hired before they graduate, and employers usually pay the remainder of the students' schooling. Even students not wanting to continue after the first year of school found work as assemblers and fabricators.

Until April 1972, when the first students graduated as laser/electro-optic technicians from Texas State Technical Institute, electronic engineers and technicians with additional on-the-job training had acted as laser technicians. Although this appeared to be one possible way to satisfy a demand for technicians, it met limited success. According to TERC,

> . . . these "converted techs" usually do not have the fundamentals in lasers and optics and they require years to become familiar with the wide variety of materials, components and special techniques used in the field.

There appears, however, to be a need for short courses and workshops, as well as two year training programs, in order to retrain and update existing employees.

Employment Outlook

Spectra Physics, a forerunner in laser technology, expects to hire thirty to thirty-five laser technicians each year for several years. Seventeen employees will fill new jobs, while half will replace employees who have left the company. Each of the two branches in one scientific laboratory expects to hire ten technicians this year and ten each year for the next several years. One source projects a need for 500 additional technicians nationwide by 1980.

Fourteen schools across the nation have laser/electro-optics technicians programs that use curriculum developed by TERC. Over 570 students, full or part-time, are currently enrolled in these programs, while two additional schools began programs in autumn 1979. Graduates of these schools should satisfy needs for technicians in the near future.

Requirements for technicians in terms of abs lute numbers is unclear. Future demand depends on how much business and industry will use lasers either for the first time or in an expansion of uses in existing areas, such as the communications field. For example, lasers are coming into use for the transmission of images across the country for newspaper copy. It is reasonable to assume that laser use will continue to expand in the future.

According to the Laser Institute of America, "Current business forecasts predict that the laser/electro-optics will be one of the fastest growing fields in this country for the next 10-15 years, requiring 15% more workers each year." (Laser Institute of America)

Employment Setting

Typical employers include laser/electro-optics, electronics, automotive and materials processing industries. Job duties for an LEOT vary and may include design and support for development activities; sales and field service; or assembly, fabrication and testing in the manufacturing process. Table 1 lists ten possible occupations for an LEOT.

Career Advancement Opportunities

Career progression is unclear due to the occupation's newness. At the least, laser/electro-optics technicians should be able to advance to supervisory or managerial roles or, with additional education, to positions as laser/electro engineers.

Available Curriculum and Programs

All sixteen schools with LEOT programs are using TERC-developed curriculum. This curriculum is modular in form and is easily adapted to workshops, short courses, and to two-year technical programs.

According to the May, 1979 issue of Laser Focus, these are the sixteen schools with laser/electro-optics technician programs:

School	Address
Albuquerque Technical Vocational Institute	525 Buena Vista NE Albuquerque, NM 87106
Camden County College	PO Box 200 Blackwood, NJ 08012
Cincinnati Technical College	3520 Central Parkway Cincinnati, OH 45223
Essex County Technical Career Center	91 W. Market St. Newark, NJ 07103
Idaho State University	Pocatello, ID 83209
Lively Area Vocational Technical Center	500 Appleyard Dr. Tallahassee, FL 32304
New Mexico Highlands University	Las Vegas, NM 87701

TABLE 1

Possible Career Opportunities for a Laser/Electro-Optics Technician (Hull, 1978)

Laser Science (or engineering) Technician - works under direction of scientist or engineer in research and/or in the development of lasers, optics, electro-optics and related systems, and in military and space labs.

Laser Engineering Applications Technician - incorporates laser (as components) into systems such as radars, communications and telecommunications, and materials processors (e.g., welding, drilling and cutting machine).

Laser Systems Manufacturing Technician - fabricates and tests various laser and optical assemblies.

Laser Materials Processing Technician - processes laser materials (does welding, scribing, drilling, cutting, etching, and surface treating); works for auto manufacturers, heavy equipment manufacturers, electronic component manufacturers and the like.

Guidance, Alignment and Construction Technician - uses lasers to align and guide instruments (such as cameras), component, systems and equipment (such as earth movers).

Civil Technician - uses lasers to make distance measurements (surveys).

Laser Medical Technician - repairs, maintains and calibrates laser instrumentation.

Laser Safety Officer - inspect laser installations for safety and compliance with local, state and federal regulations.

Laser Field (or service) Technician - uses, maintains, repairs, calibrates, performs acceptance tests and inspects lasers in a variety of applications including radar, communications, control, tracking product scanners, nuclear fusion, electronics, etc. (industry, military, space).

QA/QC Technician - performs nondestructive tests by using laser holography.

North Central Technical Institute	1000 Schofield Ave. Wausau, WI 54401
Northern New Mexico Community College	3540 Orange St. Los Alamos, NM 87544
Pasadena City College	1570 E. Colorado Pasadena, CA 91106
San Jose City College	2100 Moorpark Ave. San Jose, CA 95128
Springfield Technical Community College	1 Armory Square Springfield, MA 01005
Texas State Technical Institute	PO Box 2628 Harlingen, TX 78550
Texas State Technical Institute	Waco, TX 76705
Union County Technical Institute	1776 Ratitan Rd. Scotch Plains, NJ 07076
Vincennes University	1002 N. 2nd St. Vincennes, IN 47591

Several courses appeared in the computer search for laser/electro-optics technician. Only the TERC curriculum was directly related to the laser/electro-optics field. Other courses were related to teaching techniques, art technology or to laboratory experiments using lasers. The NNCCVTE network did not identify curriculum. However, the Laser Institute of America conducts five-day intensive courses around the country and has some curriculum materials. All military curricula related to lasers are either classified or at the graduate school level.

Implications for Curriculum Development

Through information obtained from both LEOT employers and instructors, the TERC project manager feels that modifications, including additions and deletions, to existing TERC curricula are required to keep it current. To obtain specific information about updating curricula, the Center for Occupational Research and Development (formerly TERC-SW) and the Laser Institute of America are cosponsoring a conference with LEOT employers and instructors in spring, 1980.

References

Boraiko, Allen A. "Harnessing Light by a Thread." National Geographic 156 (1979), no. 4: 516-535.

Careers and Education Programs in Lasers and Electro-Optics. Waco, Texas: Laser Institute of America.

Drewes, D.W.; Spetz, Sally H.; Heath, Walter, D.; Katz, Douglas S. Current and Future Employment Opportunities in New and Emerging Occupations within Illinois. Raleigh: CONSERVA, Incorporated, 1978.

Hull, Daniel M. Development of Generalizable Educational Programs in Laser/Electro-Optics Technology: Final Report. Waco: Technical Education Research Center, January, 1975.

Hull, Daniel M. A Dissemination Model for New Technical Education Programs: Final Report. Waco: Technical Education Research Center, January, 1979.

Laser Focus Vol. 15, No. 6 (1979): 40.

Rosen, Stephen. Future Facts. A Forecast of the World as We Will Know It Before the End of the Century. New York: Simon and Schuster, 1976.

"The Technician Gap." Laser Focus 15 (1979), no. 5: 12-15. 12-15.

Winburn, D.C., and Hull, Daniel M. "Wanted: Laser/Electro-Optics Technicians." Electro-Optical Systems Design November, 1977: 101-102.

Sources

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TUMOR REGISTRAR

Tumor Registrar

Tumor registrars document data concerning the incidence of cancer and follow-up results of treatment.

Functions, Duties, and Specifications

Health care planners and medical researchers need accurate data on cancer: numbers and characteristics of persons affected, treatments prescribed, and results. A tumor registry catalogues and abstracts such information for the hospital or health care center in which it is located. The registry also "prepares routine reports and special studies based on the registry data" to provide "a base for clinical research by the medical staff" (Lowenstein, 1979).

"The objective of a tumor registrar is to establish and maintain the efficient operation of a tumor registry; to register and follow patients with a diagnosis of malignancy; to retrieve and analyze registry data; to disseminate the data in accordance with professional ethics " (National Tumor Registrars Association). The specific duties of the tumor registrar, who manages the registry, follow:

I. Administering the registry

   A. The selection of types of cases--to be included within the scope of the registry
   B. Case finding--the identification of all cancer patients diagnosed or treated by the hospital
   C. The initial set up and maintenance of files:
      1. Accession register
      2. Master patient index
      3. Primary site file
      4. Follow-up control file
   D. The establishment of workflow procedures
   E. Management techniques

II. Abstracting the cases--a review of all relevant sources of data and categorization of information such as how the diagnosis was made, treatment, spread, staging, and etiology

   A. Procedures
   B. Quality control (editing)

III. Coding of information

IV. Following up--contact of physicians, nurses, organizations such as nursing homes, coroners' offices, or hospitals for information on recurrence treatment, survival course and demise

V. Data handling--integration and analysis of data in order that it can be used to identify incidence and survival patterns and improve the quality of medical care for cancer patients

   A. Preparation of routine reports
   B. Special studies (Lowenstein, 1979; Drewes, 1978)

Specialization for tumor registry staff in the areas of patient follow-up or record abstraction is possible in larger registries.

Education and Training Requirements

The education and training requirements for employment as a tumor registrar have not been firmly established yet. The director of the Chicago Tumor Registrars Association recommends that entrants into this field have a "college degree with a major in biological science, computer coding experience, and a knowledge of medical terminology." However, as of 1978, "the only formal training available in Illinois for tumor registrars is a two week course offered by the American Cancer Society" (Drewes, 1978). A two week course is also offered in California. Drewes, et al., determined that "it is the consensus of experts in the field that the appropriate training should be a one to two year course of study, preferably offered in a community college setting."

The Department of Health, Education, and Welfare's Division of Associated Health Professions has determined the occupation of tumor registrar to be a specialty area within that of medical records technician. Therefore, much of the training requirements are somewhat similar. Following is a list of six curriculum modules suggested by the National Tumor Registrars Association to be taught in conjunction with courses in human anatomy, physiology, medical terminology, mathematics, statistics, computer sciences, and management.

I. Introduction to Cancer and Management of the Cancer Patient

II. Organization and Operation of a Tumor Registry; the Medical Record

III. Role of the Tumor Registrar in the Health Care Delivery System

IV. Biostatistics and Epidemiology

V. Automated Data Processing for Tumor Registry Data Management and Analysis

VI. Residency Training for Tumor Registrars

Employment Outlook

A tumor registry is required for any hospital cancer program seeking approval by the Commission on Cancer of the American College of Surgeons. This stipulation has caused growth nationally in the number of registries, since many federal grants require the American College of Surgeons' approval. Approximately 1,000 hospitals across the nation have approved tumor registries. They employ between one person half-time to eight full-time workers. One full-time registrar is required for each 350 new cases in a given hospital. Increased staff are necessary for more extensive studies. The National Tumor Registrars Association envisions a possible growth of one registrar for every 350 hospital beds in the country.

The Bureau of Labor Statistics projects a 28 percent growth of health record technologists and technicians between 1976 and 1985. This represents an increase of 4,505 workers.

Employment Setting

The typical setting for a tumor registrar is the registry, usually located within the hospital.

Career Advancement Opportunities

In a large registry, a tumor registrar could move from the subspecialty into management of the registry, or possible management of the entire records system for the hospital.

A primary source for workers currently includes clerical and technician-level workers from other offices within the hospital who are given on-the-job training. Accredited Records Technicians and Registered Records Administrators are also employed in registries.

Available Curriculum and Programs

The National Cancer Institute is in the process of developing self-instructional manuals for tumor registrars. These materials are designed for an individual study package. Local chapters of the American Cancer Society may also provide short-term training. The National Tumor Registrars Association is in the process of designing a certification program. It has recently completed educational standards for tumor registrars and developed a topical content outline to be included in two-year programs for tumor registrars. The Association reports that Cuyahoga Community College in Cleveland, Ohio is experimenting with the inclusion of tumor registrar related courses in their medical records curriculum.

Implications for Curriculum Development

Tumor registrars play an important role in the medical records field. The demand for tumor registrars is growing and few training materials exist. The American College of Surgeons requires that tumor registries be a part of approved hospital cancer programs. Nevertheless, the Department of Health, Education, and Welfare has not accepted tumor registrar as an independent allied health occupation, while the National Tumor Registrar Association feels that tumor registrars represent a single occupation. A need exists for the development of curriculum materials to train persons for tumor registry. As indicated within the "Education and Training" section of this analysis, only those modules not currently available within two and four year institutions (anatomy and medical terminology, for instance) need to be developed. This includes those courses, specific to tumor registration, listed earlier.

References

Administrative Procedures Manual for Instructional Program in Medical Vocabulary and Medical Chart Abstracting for Tumor Registrars. Alexandria, Virginia: Human Resources Research Organization, 1972.

Drewes, D.W.; Spetz, Sally H.; Heath, Walter D.; and Katz, Douglas S. Current and Future Employment Opportunities in New and Emerging Occupations within Illinois. Raleigh: CONSERVA, Incorporated, 1978.

Educational Standards, National Tumor Registrars Association.

Lowenstein, Florence. Overall View of the Tumor Registry. Chicago: University of Chicago Medical Center.

Self Instructional Manual for Tumor Registrars. Bethesda: National Cancer Institute, National Institute of Health.

"Unpublished Data: Occupation by Industry Matrix," Washington, D.C.: Bureau of Labor Statistics, Department of Labor.

Sources

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ENERGY RELATED EMPLOYMENT AND VOCATIONAL EDUCATION DURING THE 1980s

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Energy Related Employment and Vocational Education During the 1980s

Introduction

Imbalance between domestic supply and demand for energy has created or reinforced serious economic problems for the nation. The economic environment of the 1970s and early 1980s cannot be separated from increased reliance on expensive oil imports. Unusually high unemployment, price instability, slow growth in productivity, and a large balance of payment deficit are all linked to excess demand for domestically produced energy. Although national policies in response to this energy situation may change during the next decade, a basic underlying strategy has recently emerged. It involves the following: (1) overall conservation to reduce energy demand, (2) more rational pricing policies to allow domestic prices to reflect more closely the higher world prices, (3) increased use of coal as a substitute for oil and natural gas, and (4) development of solar and other unconventional energy resources. These policies will have far reaching effects. In addition to altering the energy supply mix, they will influence overall economic performance, employment and the allocation of labor in various activities (Finn, 1979).

This section analyzes employment impacts of national energy policy and the energy transition expected over the next decade. If national goals are to be met, appropriate quantity and quality of workers must be forthcoming. The role of vocational education in providing entry level employees for new and existing energy jobs is discussed in each energy segment, and an analysis of existing and planned vocational school and community college programs in energy fields is discussed within the framework of future curriculum development.

The hope is that some of the difficulties associated with program planning can be reduced. A lack of information concerning the impact of energy developments on future jobs--or more specifically the skills required to secure the jobs--has been expressed by many educators. Will the jobs be at the entry level, or will they be filled through upgrading of existing employees? Will vocationally trained persons have reasonable access to jobs, or will entry occur through other avenues? Do new skills require vocational educators to create new curricula or to modify existing programs?

The recent past provides two examples relevant to the current energy situation. In the first case, environment concerns have caused federal and state agencies and vocational schools and community colleges to conduct needs assessments; hold conferences; develop curricula; and train environmental technicians with skills in water, air, and soils pollution. Although experts projected great demand for graduates, the environmental technician never materialized as an occupation, and only programs that provided trained water and wastewater plant operators placed their graduates. Multipurpose programs have disappeared.

Developments in training of allied health professionals represents the opposite extreme. Vocational schools and community colleges have been responsive, and a survey of community colleges for 1972-1973 revealed 1,463 programs covering 76 curricula in the allied health fields (Hawthorne, 1974). Six years later, concern now centers on acute maldistribution of medical personnel in medical professions and the resulting occupational proliferation and specialized accreditation (Kinsinger, 1979).

In a time of declining enrollment as well as increasing costs in establishing new programs, vocational education is moving cautiously in introducing programs dealing with specific energy fields. Full-scale programs seldom start before certain placement opportunities exist. Educators give careful attention to local industry needs. Accurate anticipation of future employment needs, however, can significantly reduce lag in supplying appropriately trained individuals.

Preliminary Considerations

The relation of national energy policy to education and training needs is not a straightforward process. Before labor requirements can be estimated, an assessment of developmental directions is needed. Such an assessment is difficult considering the multifarious nature of energy policy. A complex set of laws, regulations, and initiatives must be viewed as a whole to ascertain the aggregate economic effects. These must then be converted to skill specific labor requirements before educators can begin to plan programs. Fortunately, some of this analysis has been done.

Recent policy developments. National policies that influence the development and use of energy resources are not new. For example, price regulation of natural gas began with the 1938 Natural Gas Act, and oil import quotas began in the 1950s. Supply interruptions and price increases associated with the formation of OPEC and the 1973-1974 oil embargo, however, demonstrated the need for a new, coherent energy strategy. As a result, in April 1977 President Carter outlined a plan for legislation aimed at balancing domestic supply and demand for energy. This First National Energy Plan (NEP I) had the following three principal objectives:

Immediate Objective - to reduce dependence on foreign oil and to reduce vulnerability to supply interruption

Mid-Term Objective - to keep U.S. oil imports low in preparation for the period when world oil production approaches its capacity

Long-Term Objective - to develop renewable and inexaustible energy sources to sustain long run economic growth

These objectives were formulated with the assumption that for the foreseeable future, the U.S. would go through a major energy transition. NEP I called for some specific legislative action which would help smooth out the impact of inevitable changes. The basic underlying strategy involved (1) conservation of all energy, (2) rational pricing of energy resources, (3) coal conversion to reduce oil and gas usage, and (4) development of unconventional fuel sources. At this time, the use of light-water nuclear reactors was considered an important source for electrical generation. Public concern over health and safety problems has left nuclear power a less certain source than at the time NEP I was presented. National policy toward nuclear energy continues to be a major area of confusion in formation of long run energy strategies.

After months of debate and deliberation, Congress passed legislation designed to fulfill many aspects of NEP I. Signed into law on October 15, 1978, the legislation became known as the National Energy Act (NEA) and consists of five five separate laws (PL 95-617 through PL 95-621) designed to respond to different energy problems outlined in the National Energy Plan. With their primary purpose, the five pieces of legislation are:

The National Energy Conservation Act - to provide for regulation of interstate commerce so as to reduce the growth of demand for energy through (a) energy conservation and (b) development of solar and other alternate energy sources

The Power Plant and Industrial Fuel Act (Coal Conversion Act) - to promote the use of fuels other than oil and natural gas in the production of energy in new and existing electric power plants and other major fuel-burning installations

The Public Utilities Regulatory Policies Act - to alter price and other regulations on public utilities in such a way as to encourage conservation and efficient use of electricity and to improve wholesale distribution of electric power while maintaining equity in the rate structure

The Natural Gas Policy Act - to eliminate the distortions caused by two-tiered (interstate/intrastate) pricing of natural gas and to remove "outmoded regulatory burdens" associated with sales in interstate markets

The Energy Tax Act - to provide tax incentives consistent with the purpose of (a) The National Energy Conservation Act and (b) The Coal Conversion Act

Provisions of each law are consistent with their purpose and conform closely to the strategy outlined in NEP I. Together they provide a fairly consistent set of regulations, loan programs, grants, and tax incentives aimed at decreasing energy demand through conservation and stimulation of supply.

But this is not the end of the process. Even in the period since passage of NEA, new policy directives have come into being. In 1979, the president submitted to Congress, a Second National Energy Plan (NEP II). In addition to reaffirming provisions of the National Energy Act, NEP II establishes new initiatives. The planned, phased decontrol of domestic oil prices and a windfall profits tax on oil companies are the most notable recommendations; but other proposals aimed at strengthening incentives for conservation and alternate fuel use are also included.

But even NEP II has been superceded by initiatives announced by the president in July, 1979. The president recommended that (1) a freeze on U.S. oil imports be imposed at or below the level of 8.5 million barrels per day, (2) a massive program be instituted in the research and development of synthetic fuels, and (3) an energy mobilization board be created to expedite priority projects through the licensing and regulatory process. Added to other energy policies, the goal is to reduce oil imports to less than half current level.

It is clear that national energy policy is not static but a constant process of development and transition. There is, as a result, considerable disagreement over the net effect of these policies. However, there is agreement that energy policy, economic conditions, and other factors will lead to a significant shift in national energy sources. Table 2 indicates how the Energy Information Administration of DOE expects the energy supply to change by 1995.

A shift from oil and gas to coal and other sources will be the principal characteristic of the energy transition. Accompanying this shift will be a corresponding reallocation of labor and changes in capital construction activity. A trained experienced work force will be needed to support this shift.

TABLE 2

Percent Distribution of Primary Energy Sources
(Energy Supply and Demand in the Midterm, 1979)

Energy Source	1977 (Percent)	1985 (Percent)	1990 (Percent)	1995 (Percent)
Coal	19.98	24.72	30.13	35.55
Gas	25.83	21.87	18.76	15.90
Oil	47.76	42.72	38.64	34.37
Nuclear	3.39	7.16	9.10	10.79
Other	3.04	3.53	3.37	3.38
Total	100.00	100.00	100.00	100.00

Focus of the analysis. To effectively discuss the employment, education and, training implications of national energy policy, the focus must narrow somewhat. The principle objective will concentrate on training for entry-level positions in energy fields. The majority of these positions involve training programs of two years or less. Retraining to upgrade current employees is a secondary concern. It is assumed that energy training programs have placement as the foremost criteria of success. Most programs will not be one-time affairs, and with few exceptions, programs considered will supply graduates over a number of years.

Energy related curricula include a wide range of activities. Nuclear, oil, gas, coal, solar, synthetic fuels, and conservation areas are within the scope of this analysis. The result is a diverse set of occupations and skill groups that cannot be easily compared. Because of this, many areas of energy activity are dealt with separately. Construction activity, while not specifically energy-related, will be analyzed to determine the need for special skills related to energy facilities. Coal conversion activities and the related expansion of coal mining and transportation follows. Finally, a discussion of oil and gas, nuclear power, solar, and conservation fields rounds out the analysis. Employment forecasts differ considerably for each of these areas, and skill requirements are unique to each.

Some issues to consider. In pursuing an analysis of energy policy, employment, and vocational education, there are a number of issues that are of concern. The first difficulty in assessing the viability of a program is predicting demand. The available literature is helpful, but information is generally not easily disaggregated to the local level. Education institutions have difficulty in completing required needs assessments for state program approval. Furthermore, there is little interstate cooperation between schools planning programs. Competitive programs often result in an oversupply, especially when local needs are small.

Pervasive federal involvement can also cause confusion. Delineation of authority and responsibility between agencies regarding energy education and training has not yet been accomplished. Cooperative efforts are underway, however. Difficulties in cooperation are a result of the fact that the two principle administrative agencies--Energy and Education--are both undergoing organizational adjustments.

Private industry can also be a source of confusion. While employers recognize the need for skilled personnel to accomplish production goals, information on personnel needs is often considered useful to competitors. Thus, information needed by educators is often not available. Other companies may overstate needs in order to ensure adequate applicant numbers. Still others await enactment of additional federal policies and regulations before completing plans.

Organized labor is also involved in the energy sector. In construction, mining, and nuclear power plant operation unions represent over half of all craft and technical jobs. It is not uncommon for unions to resist expansion of the work force in order to maximize benefits for existing members. Thus, bargaining agreements and local hiring practices frequently prevent access to jobs by vocationally trained persons because of apprenticeship programs of four to five years. Similarly, organized labor and trade associations are involved in training and upgrading their existing work force with needed skills rather than hiring new entry level employees with specific energy skills, e.g., welding to nuclear industry specifications (for construction craftsworkers) and solar installation (for plumbers and electricians).

Energy-Related Employment and Vocational Education

On the whole, energy supply changes will create jobs but will not require a major shift in employment for the labor market as a whole (Sathaye, 1979b; Nordlund, 1978; Analysis of

Administration Oil Price Decontrol, 1979). Impact will differ significantly, however, by industry, occupation, and geographical region. Future developments, including coal conversion, conservation, and solar energy development can have sizable employment impacts critical to fulfilling national energy goals. The purpose of this section is to analyze labor demand in various energy activities. The information, hopefully, will improve planning and institutional response by reviewing recent evidence on the direction and magnitude of energy-related employment needs. For each area of energy related activities, existing programs will be reviewed. Suggestions for future developments will be made where appropriate.

Construction activities. Whether altered by recent legislation or not, energy production over the next ten to fifteen years will generate considerable construction activity. Although sensitive to assumptions about the rate of growth of solar and nuclear energy, labor market studies suggest a rise in energy construction employment from the 1975 level of 284,500 to 486,200 by 1985 (Sathaye, 1976b). Such employment growth is necessary if investment in energy facilities is to reach the $41 billion projected for 1985. After 1985, energy-related construction is forecast to decline slightly. Thus, the most rapid growth in employment is expected during the first half of the next decade. A constraint to this growth in energy capital could come in the form of labor shortages in critical skill areas.

To predict areas where critical shortages may develop, Gallagher and Teather have analyzed the availability of manual labor for energy construction projects. They conclude that projected energy construction growth rates are unusually high and "...present substantial problems in meeting the requirements of qualified building tradesmen and quality supervision, owing in part to the large amount of time required in apprenticeship programs and the historically slow rate of growth in the number of building tradesmen" (Gallagher, 1976b). If the supply of craftworkers grows at its historic rate, energy construction activities should absorb one-third of the expansion over the next ten years.

For construction of energy facilities, the most critical shortages would be among electricians, pipefitters, boilermakers, welders, and carpenters. The use of carpenters for energy-related construction activities is slated to grow from 22,000 in 1980 to 52,?00 by 1990. As with most critical crafts, this represents a relatively small growth in comparison to the 1.1 million carpenters in the United States. The need for special skills, however, may seriously impede the flow of skilled craftsworkers to large energy projects. Insufficient labor in these areas can result in substantial delay.

Outlook for manual labor in energy construction differs significantly by region. Gallagher and Teather report that even though the level of construction is relatively low, there is already a shortage of electricians and boilermakers in the Great Lakes region. Shortages of electricians, pipefitters, and welders are predicted in the Southwest and southern California. Because of healthy growth in commercial construction, southern states can expect difficulties in finding qualified pipefitters, electricians, boilermakers, welders, and supervisors. The prolonged slump in the Northeast reduces the threat of critical shortages there, although upgrading of the current work force as well as training new workers may be necessary.

Motivated by similar concerns, Gallagher and Brady have conducted a study of future construction engineering supply and demand (Gallagher, 1976a). Based on interviews with industry managers and administrators, they conclude that a shortage of experienced personnel may occur in some engineering fields. Although an overall engineering shortage is unlikely, "...shortage of engineering managers and engineers with construction experience is of greater concern; (and) that the way to alleviate an engineering shortage is through increased use of paraprofessionals to support engineers" (Gallagher, 1976a).

Almost all major contractors as well as many specialty subcontractors are unionized. Union apprenticeship programs will be the major source for skilled craftsworkers for energy-related construction. Apprenticeship programs, currently in a slow growth period in most regions, will have to respond by expanding. This must be done in appropriate regions, keeping special skill requirements in mind.

In supplementing apprenticeship programs, high school, vocational school, and community college programs have had some success. Educational institutions working with local craft unions have provided recruitment and instructional support. Vocational schools which are adjacent to major construction projects can expect to place traditional graduates in smaller secondary construction.

Serious shortages, which might jeopardize completion schedules of major energy projects, can probably be avoided if traditional institutional programs respond. Where they fail to do so, other publicly supported training programs may supply backup; institutional barriers, however, are likely to limit the success of such activities.

<u>Coal mining and transportation</u>. A major national goal aims to reduce the use of gas and oil through coal conversion by public utilities and large industrial users. Although some shift

to coal would take place in response to economic changes anyway, provisions in the National Energy Act are likely to hasten the process. The law establishes three explicit prohibitions:

1. New electric power generating facilities are prohibited from using oil and natural gas.

2. Natural gas and oil use is prohibited in new major fuel burning installations using over 100 million BTUs per hour to fire a boiler.

3. Natural gas is to be prohibited after 1990 as a primary fuel in existing power plants.

Unless constrained by health and safety legislation, environmental regulations, inadequate transportation facilities, or other institutional and economic factors, this strategy is expected to increase coal production to nearly one billion tons by 1985. Projections of the demand for coal miners are contingent on tons mined each year, output per worker, the mix of surface and deep mining, and the number of workers leaving the industry. If, for example, one billion tons are mined in 1985 and production per worker remains constant, approximately 100,000 new jobs will exist in 1985. Forty thousand new hirings per year would be needed to meet this demand if the annual exit rate from the industry does not change (Baker, 1979).

Table 3 shows the probable impact of coal conversion on coal mining and transportation. Personnel demand for construction and operation of coal facilities will result in employment growth throughout the next decade. These estimates suggest that the entire coal industry will need to grow by over 200,000 during the 1980s. Among miners, the greatest increase will occur in eastern underground mines where an additional 68,000 workers will be needed by 1990. Relative to the existing work force, the greatest increase will occur in western strip mine employment which must grow at an annual rate of nearly 10 percent (Sathaye, 1979a).

The expected growth in coal industry employment will strain programs providing miner skill and safety training. Traditionally, the industry has hired untrained workers and trained them during their probationary and early years of employment. For these individuals, on-the-job training has been supplemented with mine technology courses in area vocational-technical programs.

Prompted by recent legislation, the coal mining industry has developed a policy on training. The Federal Mine, Health and Safety Act, for example, requires safety training for new and retraining for experienced miners. Formal skill training

TABLE 3

Labor Requirements for Construction and Operation of Coal Facilities, 1975-1990
(Sathaye, 1979a)

(Thousands of Workers)

	Construction				Operation			
	1975	1980	1985	1990	1975	1980	1985	1990
Underground eastern coal mine (2 MMT/Y)	3.6	2.8	3.7	3.5	150.6	191.1	216.1	258.9
Surface eastern coal mine (4 MMT/Y)	3.2	2.5	2.1	2.8	23.9	31.4	36.6	40.1
Surface western coal mine (6 MMT/Y)	2.3	3.7	2.5	1.9	8.2	21.1	40.7	52.5
Underground western coal mine (2 MMT/Y)	0	.2	.2	.1	6.7	8.9	10.0	12.2
Coal gasification - high BTU (250 MMCF/D)	0	10.8	10.8	14.0	0	.8	4.7	7.8
Reconversion of oil plant to coal (250 MWE)	.1	0	0	0	0	2.9	4.1	4.6
Coal-fired power plant - low BTU (800 MWE)	25.8	37.6	14.8	6.4	4.3	10.8	20.3	23.7
Coal-fired power plant - high NYI (800 MWE)	27.5	25.4	17.5	18.3	24.5	30.2	33.6	35.1
Sulfer oxide removel (800 MWE)	3.5	6.9	7.3	1.0	.8	2.9	6.5	10.0
	66.0	89.0	58.9	48.1	218.9	300.1	372.6	444.9

TABLE 3, continued

(Thousands of Workers)

	Construction 1975	Construction 1980	Construction 1985	Construction 1990	Operation 1975	Operation 1980	Operation 1985	Operation 1990
Mixed train (7,225 ton)	0	0	0	0	42.8	61.0	79.5	88.7
Coal unit train (10,500 ton)	0	0	0	0	24.9	38.5	54.1	65.7
Coal slurry pipeline (25 MMT/Y, 150 Mi)	.4	.7	1.4	1.6	0	.2	.6	1.3
Coal slurry preparation (25 MMT/Y)	.3	.3	.4	.3	0	.1	.2	.3
Coal slurry dewatering (25 MMT/Y)	.1	.1	.1	.1	0	0	.1	.1
Coal barges (21,000 ton)	0	0	0	0	2.2	3.6	5.1	6.3
Coal truck (25 T)	0	0	0	0	9.9	13.9	17.8	19.5
	.8	1.1	2.0	2.1	79.9	117.3	157.4	181.9
Total, all activities	66.8	90.9	60.9	50.2	298.8	417.4	530.0	626.8

is required for mechanics, electricians, foremen, and other supervisory personnel. The National Bituminous Coal Wage agreements of 1974 and 1978 also require mandatory training yearly for all employed miners.

Thirty-six coal mining training programs exist in vocational-technical schools and community colleges. Of these, thirty-two have been established since 1972, and thirty-one exist east of the Mississippi. They provide a variety of training programs, from an initial forty hours of required safety training for new miners through preparatory courses for experienced, employed miners prior to their taking certification tests in specific areas. Both employed miners and potential miners are frequently enrolled together in programs offering associate degrees. Maintenance equipment programs for the coal industry in both surface and underground mining also exist.

Labor union cooperation is essential to the operation of these programs. Approximately 90 percent of the underground and 52 percent of surface bituminous coal miners are affiliated with organized labor. The United Mine Workers of America represents nearly all union personnel in mines.

Acceptance of skill and safety training for miners varies by mine and location. Recent bargaining agreements, federal safety regulations, and satisfactory results from training all have had a positive effect on training. Mining curricula based on Mine Safety and Health Administration regulations provide the foundation for many courses. Vocational programs tend to be designed for the specific needs of local companies and their current regulations. The ability to find and pay qualified instructors appears to be the greatest problem.

In summary, a sufficient number of sound coal mining programs appear to exist in the Appalachian regions as well as in the midwestern states. New programs in the West will be based on demand from companies located near technical schools, while demand for miners in sparcely populated areas will tax the ability of schools to provide training.

Coal transportation facilities will have to increase along with coal output. About 12 percent of domestic coal is burned at mine sites to generate electricity. The remainder is transported by railroads (64 percent), trucks (13 percent), river barges (10 percent), and coal slurry pipelines (1 to 2 percent). An extensive survey of the nation's railroads revealed that employment related to rail transportation of coal will increase by about 55,000 workers between 1980 and 1990 (Witten, 1979). This would represent an annual growth rate of 4.5 percent (or about 6,000 workers per year)--most of it in the West. If current employment patterns persist, one-fifth of these jobs would be in nonmanual supervisory or managerial fields. Remaining employment growth would occur among manual workers. Those holding most positions in the latter category receive training on the job. Seventeen percent of all manual workers are in critical skill areas. These jobs, essential to efficient operation, include primarily electricians, carpenters, masons, and train crew personnel. Some vocational programs for railcar construction and repair workers exist (primarily sheet workers and welders), but little is known about the impact of vocational training in supplying other railroad industry personnel. Traditionally, most railroad workers have been trained on the job or in union programs.

Oil and gas. Public policy toward oil and natural gas has also been favorable. For natural gas, the most notable change comes in the Natural Gas Policy Act of 1978. As part of NEA, this act extends natural gas price control over intrastate as well as interstate markets. In so doing, it has provided for decontrol of new, high cost gas. The net effect will be to allow the real price of gas to increase to reflect replacement costs of gas.

Similar changes are taking place in crude oil and refined petroleum product markets. Control of prices, under presidential discretion, has kept domestic oil prices below world prices. Current administration policy will allow a gradual decontrol to take place so that domestic prices will reach world prices by 1981.

It is difficult to predict employment needs for the entire oil and natural gas industry. New drilling and extraction methods may eventually increase domestic production, but at present, these methods are experimental, and future levels of output are unknown. Emphasis on recovery of oil and gas from low producing wells will increase, but the amount may not be significant to overall national needs.

While future output is uncertain, certain activities can be predicted with more assurance. While the exact number is unknown, employment in exploratory drilling operations is certain to increase. Conditions have become particularly favorable to exploration activities. For example, the wellhead price of natural gas increased at an average annual rate of 10.44 percent between 1970 and 1977 (Statistics and Trends of Energy Supply, 1978). Over the same period, the wellhead price of domestic crude oil increased at an even more rapid 15.21 percent annual rate. Interestingly, over this same period, exploratory drilling costs per successful oil and gas well only increased approximately 3 percent per year. This slow increase in costs for exploratory drilling can be explained by the rise in successful drilling rates. Twenty-seven percent of all exploratory oil and gas drilling was successful in 1977 as compared to 16.5 percent in 1970. Thus, throughout the decade, the economic environment has been favorable to exploration and extraction activities.

Refining, transportation, distribution, and other activities associated with oil and gas production will vary with output. But, exploration drilling is certain to increase. The Bureau of Labor Statistics estimates a corresponding growth in employment. The number of oil and gas extraction workers is projected to exceed 600,000 by 1985, a 50 percent increase (Occupational Outlook Handbook, 1978). Such a growth rate would greatly exceed forecasts for the labor force as a whole.

If accelerated exploratory activity and enhanced oil and gas recovery techniques prove successful, other production activities will also grow. This activity, however, will tend to be concentrated in certain geographic locations. Although some petroleum production and refining takes place in most areas of the country, large employment opportunities in the industry are limited to a few states. Six states (California, Illinois, Louisiana, Ohio, Oklahoma, and Texas) have substantial numbers of workers employed both in petroleum production and in refining. Alaska as well as Colorado, Kansas, New Mexico, and Wyoming produce large amounts of petroleum. Other major refining states are Indiana, New Jersey, New York, and Pennsylvania. Many new jobs in the industry will be located in the Rocky Mountain states or at off-shore drilling sites. Workers are also needed at the many overseas facilities owned or operated by U.S. oil companies.

A limited number of programs exist for the training of oil and gas workers. Fifteen vocational schools and community colleges have petroleum programs developed primarily between 1973 and 1975 (Doggette, 1976). An additional 135 education institutions offer chemical technology programs many of which refer graduates to refinery positions.

Directors of petroleum training programs report increased interest by many companies in their graduates. Bias against specialized petroleum programs has decreased as companies increasingly prefer entry-level employees to have electronics and instrumentation training to support their oil and gas knowledge. The most successful programs, as would be expected, work closely with petroleum companies to provide required skills.

Future growth depends on local needs. Eastern seaboard states, for example, have planned potential programs to support off-shore exploration, but all have declined to introduce major program offerings until need is demonstrated. Schools in Texas have strengthened existing programs to support renewed employer interest. Because oil and gas programs are considered old, however, comprehensive curriculum material has not been systematically gathered.

Nuclear power production. A source of enormous uncertainty that clouds forecasts of the energy future is the role of nuclear power. It is unlikely that construction of nuclear power plants will cease altogether or that anti-nuclear forces will become so influential that existing plants will close. What can be expected are (1) new, tougher licensing procedures, (2) closer federal supervision, and (3) more stringent certification requirements for operators. The last change is a virtual certainty and has important implications for nuclear technician training programs.

In the past, vocational education programs have had difficulty training for the nuclear industry. The problem lies in the lengthy delays in construction and start up of nuclear utilities. Enterprising institutions planned and initiated nuclear technology programs years in advance of utility needs. The sixty to seventy nuclear power plants presently operating are less than half the number forecast by many experts a decade ago. Similarly, the 4,500 technicians presently employed in reactor operation and maintenance are significantly below projections on which education institutions designed programs in the early 1970s.

Of eighteen known nuclear programs in technical schools and colleges, all but three are less than ten years old. Two older programs recently ceased training due to recruiting difficulties and high operating costs.

Approximately 30,000 technicians were identified in 1977 as being employed in the nuclear field. The nuclear fuel energy segment includes the mining, milling, and conversion of uranium. This is followed by its enrichment, fabrication, and use in power plants and then by reprocessing and waste disposal. Most known schools with nuclear technology programs train in only one or two specialties, usually health physics and instrumentation. Programs tend to be small for one or more of four reasons: (1) lengthy construction delays prevent effective planning, (2) local labor markets have become oversaturated, and the graduates must be placed nationally, (3) math and science requirements tend to be more rigorous than most one and two year technology programs, and (4) adverse publicity toward nuclear technology makes recruiting of students difficult.

A 1978 study (Blair, 1979) of 1,800 International Brotherhood of Electrical Workers employed in nuclear utilities (a 28 percent sample) identified 325 employees with associated degrees. Only seventeen of these had associate degrees in nuclear technology. This suggests that fewer than 100 employees in the nuclear utility industry have acquired nuclear technology associate degrees. Under contract to the Office of Education, nuclear technology curriculum materials for two-year schools have been developed by Technical Education Research Center, in five occupational areas. Most existing schools with programs, however, developed their materials independently, and have usually been supported by the utility or private company that needed technicians.

The Center for Nuclear Studies, Memphis State University, has negotiated performance contracts with some utilities having nuclear plants to upgrade the skill level of their employees. In many instances, this training takes the place of vendor training that had been previously offered by the companies that designed the reactors.

Given present uncertainty about future growth rates in the industry, few education institutions seem interested in risking equipment, time, and start-up costs necessary for sound programs. If a school possesses a strong employment commitment from a nearby company or utility, sufficient curriculum material is available for adaptation to specific needs.

Solar energy activities. Specific targets in solar energy* are elusive, but qualitatively, a clear long-run goal is to increase the nation's reliance on various solar energy technologies. Tax credits, assistance programs, and demonstration projects constitute a program designed to provide incentives to developers and users of solar energy systems. Jobs will be created in all areas: design, manufacture, installation, and maintenance of solar systems. But, for the forseeable future, the major employment impact will occur in the solar flat plate collector industry. Although considerable variations exist between installations, the basic technology for solar space and hot water heating is tested, proven, and serves as the foundation for a rapidly growing industry. Sales, including installation, are reported to have increased tenfold between 1975 and 1977 (Maidique, 1979).

*Although solar energy in some taxonomies includes wind, water currents, and biomass, for this discussion only direct heat energy is included.

While the technology for the design, manufacture, and installation of flat plate collector systems is fairly well-known, labor requirements for implementation of this technology are not. After surveying a number of studies, Mason and Armington conclude that "...there is considerable divergence among estimates of direct labor requirements for solar technologies" (Mason, 1978). Much of this variation is explained by the newness of the industry. Inefficient producers have not been driven out yet by competition. Emerging industries generally go through a period of decreasing costs and increasing productivity. Employment forecasts made on the basis of current labor/output ratios are likely to overstate employment needs. So while numerical estimates are unreliable, a consensus exists that solar heating will expand and with it will be substantial growth in employment.

Table 4 shows the occupational skill mix required for installation of solar collector systems. Skilled craftsmen and technicians represent over 75 percent of those employed (Blair, 1978). Table 5 gives a description of the skills required by a broader range of solar system workers. Many of the skills required for the design, fabrication, installation, and maintenance of solar flat plate collector systems can be taught in vocational programs (Burns, 1979).

To date, little is known about the labor market experience of the graduates of solar energy programs. A preliminary assessment, however, suggests that a high proportion of initial graduates of solar programs find work in solar related activities. What is still unknown is the appropriateness of the skills being taught as the industry expands.

One extreme example exemplifies the problem of predicting the direction of growth for solar related vocational education. In 1978, a community college with a two-year solar program reported an average of six job offers for each of its ten graduates. In 1979, the same program had 400 people enrolled. Predicting demand for future graduates is uncertain even with the positive placement record.

The problem of coordinating the supply of graduates with the demand for solar energy workers is more than a program specific concern. In 1978, twelve programs were identified as training solar technicians. One year later, ninety-one schools in thirty-one states reported programs or vocational offerings (Corcoleotes, 1979).

Predicting demand and placing graduates is not the only concern of educators developing solar programs. Jurisdictional concerns between unions over which building-crafts workers can install solar units have not been resolved. Furthermore,

TABLE 4

1978 Solar Energy Collector Installation Employment Mix, Air Versus Liquid Systems
(Blair, 1978)

Occupation Group	Air and Liquid (Percent)	Air (Percent)	Liquid (Percent)
Manager/administrative, other professionals	17	19	15
Other support	2	5	0
Technicians (e.g., drafters, solar, solar-sheet metal, electrical-electronics)	24	10	37
Skilled crafts (e.g., sheet metal, solar mechanics, plumbers, carpenters, general crafts)	52	57	46
Semi-skilled, unskilled	5	10	2
Total	100	100	100

NOTE: No engineers or scientists were reported in installation activities in the case studies.

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TABLE 5

Solar Heating Applications: Job Skill Requirements, and Job Responsibilities
(Solar Energy Task Force Report on Education and Training, 1979)

Job	Skill Requirements	Job Responsibilities
Sales	understand both solar and conventional HVAC systems, and how they tie together	describe different systems, show and explain finished product, explain system performance, recommend optimum system, explain system operation and maintenance, explain impact on comfort, estimate system costs
System designer	detailed operational knowledge of conventional and solar systems; ability to calculate system size and performance using computer/calculate programs such as SOLCOST, FCHART, etc.; ability to create detailed drawings and charts for installation and maintenance	interface between project architect and mechanical engineer, ensure successful system installation and and interconnection with conventional HVAC, select proper system type, select optimum system size, calculate system performance, identify impact on building design, provide operational details and drawings for installation and maintenance describe schedules and operations for maintenance

TABLE 5, continued

Job	Skill Requirements	Job Responsibilities
Installer	intricate knowledge of installation and construction of solar component hardware, fundamental knowledge of HVAC systems, general knowledge of system operation and design, knowledge of local building codes, ability to translate blueprints into system, understanding of thermal expansion	install collectors, make system connections to collectors; test system for internal and external leaks; flush and fill system (if liquid); locate, construct and install storage; connect pipes and/or air ducts to storage; install and check hardware (storage sensors, heat exchangers, pumps, valves, filters); hookup system with backup unit
Electrician	need not be familiar with detailed operation of solar systems, needs to interpret drawings and blueprints for hookup of solar control system	provide power to control unit, blowers, pumps, and safety controls; install and check sensors and thermostat; connect mechanical device controls to controller; check out control modes
Supervisor	knowledge of building codes and ordinances	establish schedules for workers and delivery of materials, ensure conformance with codes and ordinances, ensure conformity of installation with original system design

TABLE 5, continued

Job	Skill Requirements	Job Responsibilities
Service or maintenance technician	well-versed in all facets of solar system operations, working knowledge of controller circuitry and associated wiring, experience in motor repair and operation and in valve operation	understand general system operation, identify the control modes of the system, determine if mechanical devices are operational, identify proper points for fluid temperature measurement, determine if heat flows are within acceptable tolerances, identify location of problems, fix problems, or know proper person to contact, perform periodic maintenance checks and tasks, perform system start up for small system

different system designs require different skills. Liquid collector systems rely heavily on plumbing and pipefitting skills, while air systems rely more heavily on sheet metal work. Many building crafts add extra persons to their crews to compensate for the additional time and labor required to install a solar system. In addition, union spokespersons have criticized vocational education in solar energy as not being directed to the needs of the industry. Their preference is for union apprenticeship programs to provide necessary training and experience for new workers.

Union jurisdiction and approval is of greater concern in heavily unionized commercial and industrial construction. A high proportion of residential construction workers are non-union workers. This, combined with the more rapid growth of residential solar use, has resulted in existing vocational programs being designed to support residential construction.

Vocational education is presently training a large number of persons interested in solar energy as an avocation. The courses have attracted a variety of professionals and laypersons who are promoters of solar development. Because of the rapid growth of solar education offerings, it is not possible to generalize on course contents. Job placement is not a criteria of success for programs designed to promote solar energy.

The supply side of solar has grown so rapidly that educators need to continually examine their offerings against industry and, specifically, local company needs. Curricula are being developed at many schools. Educators can benefit from close communication with the Solar Energy Research Institute and the four regional solar commercialization centers.

Conservation activities. A major strategy of national energy policy lies in conservation. There are a number of minor provisions in the National Energy Act bills that support conservation. The Public Utilities Regulatory Policies Act requires utilities to consider the adoption of practices that would have the effect of increasing rates during periods of peak demand. The Natural Gas Policy Act changes natural gas price controls which should increase costs to many users. But the National Energy Conservation Policy Act and the Energy Tax Act contain the most important provisions. The former requires most regulated and unregulated utilities and home heating suppliers to provide audits of residential units. Although the exact nature of the audits is uncertain, occupants are supposed to be provided with cost and savings estimates of energy saving measures and the names of approved installers and lending institutions. Funds are also provided for energy audits of federal and other public buildings. Large industrial users are to report on their energy use and efforts to conserve.

The Energy Tax Act reinforces conservation incentives with tax changes. Homeowners, for example, are given a tax credit of 15 percent, up to a maximum of $300, for installation of energy saving devices. A similar credit of up to $2,200 exists for investments in solar or other alternate energy equipment. Certain business tax changes encourage industrial conservation. In addition to legislated conservation incentives, oil price decontrol and moral persuasion should encourage reduced energy use.

Energy audit and conservation activities will, in all likelihood create employment opportunities in two important areas: (1) residential conservation; and (2) conservation in large public, commercial, and industrial buildings. Although skilled individuals will be required for these activities, it is not yet clear what background will be needed.

While educators have contacted private industry and public utilities to explore the need for energy conservation personnel, few educational institutions have energy conservation technician programs. Three barriers seem to prevent significant employment in the conservation field. The public utilities, hospitals, and other institutions have waited for final regulations (NECPA or PURPA) requiring a particular type of audit. To date the professional interpretations on what the various audits require vary sufficiently to question the skills needed by the auditor. Using estimates on the rate of onsite audits presently being requested, 8,600 onsite auditors may be needed per year through 1985 (Finn, 1979).

The second barrier is that the private sector presently does not believe that employment of conservation personnel and the application of conservation practices provides sufficient economic rewards. Experience indicates that three to five years payback is required by most companies before they will install conservation measures. The third is that the private sector does not now consider an energy conservation worker to be a legitimate occupation, meaning a willingness to recruit and employ someone with sufficient technical skills and a job description for energy conservation. Unless energy conservation is practiced as a company policy, which in turn is managed by a supervisor in charge of conservation, it is not likely that a job description will be created for an energy conservation technician. Traditionally, maintenance engineers are assigned the additional duty of energy conservation. Moreover, small businesses cannot afford to employ such specialists.

At this stage in identifying energy conservation as an occupational field, there is wide disparity between educators and potential employers on what skills a technician ideally should have. Public utilities vary in response to commercial and residential customers needing audits. The Tennessee Valley Authority (TVA) initiated its home energy audit program in 1977 and thus, has some experience in evaluating needed skills. The TVA energy conservation adviser must conduct on-site energy audits to determine deficiencies in both commerical and residential dwellings. The adviser must also make inspections of dwellings after conservation measures have been taken. Then, if additional installation is needed, the adviser must convince the owner to install additional materials. For these jobs, TVA has employed graduates with two and four year college degrees who have a physics and math background. Short courses and on-the-job training have been used to supplement general skills. A second utility retrained its customer service representatives in gas sales with short courses to conduct audits and provide advice.

A different anticipated demand for energy conservation technicians comes from the need to provide for the operation and maintenance of complex technology and equipment installed in large buildings and factories. The optimum use of this new generation of mechanical, electrical, electronic, and electro-mechanical equipment will potentially be a major source of energy conservation. Thus, a new generation of technicians may be needed to perform operation and maintenance functions.

Two representative models of energy conservation programs have been funded by the Department of Education. Project EFFECT, located at Indiana University at South Bend, is a three-year experimental program in curriculum development focusing on energy conservation, technology, and training. Project EFFECT has developed a curriculum to provide competencies for energy extension agents. The competencies lie in two broad areas: technical skills to conduct an energy survey of residential and light commercial structures and communication skills to conduct community energy conservation programs. The program has a core, six-month curriculum of 588 hours and a two-month field practicum. To date, it has had only limited success in placing its graduates.

The second project, conducted by Technical Education Research Center-Southwest, was funded in early 1979 to provide a broad technical-based interdisciplinary curriculum for use by two-year postsecondary institutions to prepare technicians for work in energy-related fields. To date, the program has developed a two-year curriculum which is being field tested in at least ten vocational schools. The advisory committee felt that there is no common agreement on skills needed for energy conservation but identified four areas of potential employment in energy: research and development, production, use, and conservation. The title of its curriculum, Energy Conservation-and-Use Technician, recognizes the diversity of the curriculum and the general uncertainty as to the need for a new two-year

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may result in critical labor shortages. The resulting increase in wages may render unfeasible energy sources that would otherwise be competitive.

Vocational educators should also strive to define skill requirements as carefully as possible when planning energy-related training. All energy sectors need skilled, experienced workers, but all too frequently the dialogue between educators and employers is too imprecise. In every energy training area study, the strong programs are the ones designed to fulfill existing local needs. The axiom is as true in coal mining as in conservation and solar. For initial placements, educators will have to convince employers in many energy companies of the benefit derived from skilled entry-level workers.

Vocational educators need to share rather than compete in their energy offerings. Energy training areas, with the possible exception of conservation, have been sufficiently introduced. The "wheels" have been invented in numerous locations and need only to be improved by mutual support.

The majority of vocational education and training for energy-related jobs will come from traditional programs already in place. Existing programs should be examined and updated. Building trade and HVAC programs, for example, can support solar and conservation courses.

There is not likely to be a need for a generalized energy technician with experience in everything from wood chips, to solar, to wind mills. However, courses in some or all of the energy technologies may be viable offerings at many schools and colleges.

The distinction between job related placements and vocational skill acquisition is presently important in solar, conservation, and other emerging areas. Single examples of placements should not be used to justify full-size programs. In developing training areas with uncertain placement, general as well as specific job training should be provided to assure acquisition of marketable skills.

In considering these suggestions, the interrelationship between energy policy, economics, and employment must be kept in mind. Virtually every energy related economic development generates some critical employment needs. The response of educational institutions to these needs has far ranging implications and may influence the future course of energy development.

References

Analysis of Administration Oil Price Decontrol and Tax Proposals Using Macroeconomic and Energy Models Annex 2 to Appendix C of NEP II, August 1979.

Baker, Joe G. "Coal Mining Training Requirements, 1975-1985," presented at the Education, Business, and Labor Affairs Conference, Washington, D.C., January 1979.

Blair, Larry M., and Doggette, John R. "Education, Training, and Work Experiences Among Nuclear Power Plant Workers," presented at the International Symposium on Manpower Requirements and Development for Nuclear Power Programs, Saclay, France, April, 1979.

Blair, Larry M.; Burnett, William; and Mason, Bert. Solar Energy Employment: Information from Case Studies, Oak Ridge, Tennessee: Oak Ridge Associated Universities, December 1978.

Burns, Barbara. Beyond the Body Count, The Qualitative Aspects of Solar Energy Employment (Interim Progress Report). Golden, CO: Solar Energy Research Institute, October, 1979. (Final document planned for 1980 publication.)

Corcoleotes, George; Kramer, Katherine; and O'Conner, Kevin. Solar Energy Technical Training Directory. Golden, CO: Solar Energy Research Institute, June, 1979.

Doggette, John R. Energy-Related Technology Programs in Community and Junior Colleges, An Analysis of Existing and Planned Programs. Washington, D.C.: Energy Research and Development Administration and American Association of Community and Junior Colleges, 1976.

Energy Supply and Demand in the Midterm: 1985, 1990, and 1995, Washington, D.C.: Energy Information Administration, U.S. Department of Energy, April, 1979.

Finn, Michael, and Stevenson, Wayne. Employment, Education, and Training Implications of the National Energy Act (Draft Report). Washington, D.C.: Office of Education, Business, and Labor Affairs, Department of Energy, November, 1979.

Gallagher, J. Michael, and Brady, William J. "Availability of Engineering Personnel for U.S. Energy Development Programs." prepared for Energy Research and Development Administration by Bechtel Research and Engineering, 1976a.

Gallagher, J. Michael and Teather, Jeff S. "Availability of Manual Manpower for U.S. Energy Development Programs," prepared for Energy Research and Development Administration by Bechtel Research and Engineering Corporation, 1976b.

Hawthorne, Mary E., and Perry, Warren J. Community Colleges and Primary Health Care: Study of Allied Health Education Report, pp. 97-99. Washington, D.C.: American Association of Community and Junior Colleges, 1974.

Kinsinger, Robert E. "Where in Health are Community Colleges?" Community and Junior College Journal, May 1979, pp. 15-21.

Maidique, Modesto. "Solar America." In Energy Future, edited by Robert Stobaugh and Damiel Yergin, p. 188. New York: Random House, 1979.

Mason, Bert and Armington, Keith. "Direct Labor Requirements for Select Solar Energy Technologies: A Review and Synthesis." Working paper prepared for Solar Energy Research Institute, Golden CO. August, 1978, p. 24.

Nordlund, Willis and Mumford, John. "Estimating Employment Potential in U.S. Energy Industries," Monthly Labor Review, 101, no. 5, May, 1978.

Occupational Outlook Handbook. Washington, D.C.: Bureau of Labor Statistics, Department of Labor, 1978, pp. 620-21.

Sathaye, Jayant, and Ruderman, Henry. "An Assessment of National Consequences of Increased Coal Utilizations" prepared for U.S. Department of Energy, February 1979a.

Sathaye, Jayant and Ruderman, Henry. Direct and Indirect Impacts of A National Energy Plan Scenario. Energy and Environment Division, Lawrence-Berkeley Laboratory, 1979.

Solar Energy Task Force Report on Education and Training presented at the Department of Energy National Energy, Education, Business, and Labor Conference, January 1979, prepared by the Solar Energy Research Institute.

Statistics and Trends of Energy Supply, Demand, and Prices. Washington, D.C.: Energy Information Administration, U.S. Department of Energy, May, 1978.

Witten, John M. and Desai, Samir A. Rail Transportation Requirements for Coal Movement in 1985 prepared for the Office of the Assistant Secretary for Policy, Plans, and International Affairs, Department of Transportation, NTIS, December, 1979.

Sources

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MICROPROCESSING RELATED OCCUPATIONS AND TRAINING

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Prepared for the National Center
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under a consultant agreement

Microprocessing Related Occupations and Training

Industry History and Growth

In 1968 a small company by the name of Viatron announced its intention to build a data-handling system which would rent for $40 a month (Electronics, 1968). The heart of the Viatron unit was an 8-bit microprocessor. Unfortunately the company went bankrupt shortly thereafter. In 1971 the Intel Corporation was the first to market microprocessors and exploited them to the fullest. By 1974 the microprocessor explosion had revolutionized the electronics industry. Today there are numerous manufacturers of microprocessors (A short listing is provided in Appendix C-1).

Definition

Advances in the area of large-scale integration of circuits have led to the development of a solid state device, the microprocessor, which is a small data processor. As defined by Larson, Rony, and Titus, a data processor is a--

> ... digital device that processes data. It may be a computer, but in a larger sense it may gather, distribute, digest, analyze, and perform other organization or smoothing operations on data. These operations, then, are not necessarily computational. Data processor is a more inclusive term than computer. (1975)

A microprocessor can be used to make microcomputers or minicomputers. In such cases, the microprocessor represents the control and processing portion of a small computer. Unlike a computer, it has no memory but can handle both arithmetic and logic operations under program control.

Applications

The microprocessor is such a useful tool and its applications are so varied across technical disciplines that people are already taking them for granted. In industry the microprocessor is in widespread use as an industrial control. They serve in new typesetting equipment, and in the terminals and typewriters of modern business offices. Microprocessors have also been used in controlling industrial sewing machines in the manufacture of clothing and in controlling the film processing plants of large photo laboratories. Steel plants, welder control systems, water quality control, energy conservation, and even lumber mills use the microprocessor in their control systems. In addition, the microprocessor has proved most useful in traffic control. Soon microprocessors will help to control traffic movement during rush hours and at the same time plot the best route for fire equipment and emergency services.

In the consumer market the microprocessor has found utilization in microwave ovens, electronic doorbells, electronic thermostats, and even the so-called smart telephone that remembers the last number dialed. They are presently used in home video recorders and may be programmed to tape favorite television shows while no one is at home. Microprocessors control the new audio cassette tape players as well as record turntables for more accuracy. Many home security systems now also use the microprocessor. New television games under microprocessor control are exciting and at times frustrating to a new player. They come with trills and noises. Many pinball machines are now totally electronic also. Under microprocessor control, these game machines can create a variety of illusions that are unlimited in scope and application.

With its application as a microcomputer, the microprocessor has opened doors to a futuristic world.

> Automobile manufacturers are already introducing microprocessors in automobiles to control timing, ignition and fuel flow, and plan later to have microprocessors control braking and transmission and to monitor performance and detect deficiencies. (Roland, 1979)

At the present time the microprocessor can control ignition timing, fuel injection systems, anti-skid controls, and diagnostics and cruise control systems in many cars. In business, the typewriter aided by processor control can type form letters or multiple original copies. In supermarkets cash registers maintain store inventory while checking out the customer. Home computer systems, built by Radio Shack, Heathkit, Altair, IMASA (selling for approximately $1,000), all use microprocessors. A similar system ten years ago would have cost more than $20,000.

Manufacturers of electronic test equipment such as Hewlett-Packard, Tektronic, Fluke, and Systron-Donner use microprocessors in their instruments to control the test procedures. They even perform self-checks on the instrument to let the operator know that the equipment is operable. If a breakdown occurs, the instrument can help in diagnosing its trouble (Roland, 1979).

> The low cost of microcomputers often makes it more economical to dedicate one to a particular task than to share a large computer with other tasks or to design and build a specialized device for that application. It is much less costly to correct errors in the programs, or software, than it is to correct errors in the hardware, especially after the device is in production and being delivered.

Microprocessor Related Occupations

Microprocessor technicians are present in every walk of life. Depending on the job and company, they may be called electronic technicians, computer engineers, computer service engineers, field service technicians, digital technicians, or industrial technicians. They are present in almost all industries today; functions range from maintainence of television games to complex industrial control processes.

The job outlook for digital technicians is excellent. The demand is here now and will continue in the future. Industrial representatives that come to this writer's school speak of technician shortages and the importance of microprocessors in new control systems. The new uses for microprocessors in every day life helps to explain the demand for digital technicians in our society. The expanding need for digital technicians is climbing faster than the number of trained technicians entering the workforce. According to Occupational Outlook Handbook,

> Employment of computer technicians is expected to grow much faster than the average for all occupations through the mid-1980's. As the nation's economy expands, more computer equipment will be needed to install and maintain it ....The development of new uses for computers in fields such as education, medicine, and traffic control also will spur demand.
>
> Because most technicians are young, relatively few openings will stem from deaths and retirement. Most openings will result from rising demands for the service of computer service technicians. (1978)

Since many microprocessor applications and uses fall in the area of microcomputers or minicomputers, most computer service technicians service microprocessor base systems. Many of these digital technicians will work in an industrial environment. Some will lubricate the mechanical systems connected to the microprocessor. All technicians will have to check mechanical connections in the wiring of microprocessor systems. Some technicians will also be required to work with people when person and machine interface in computer systems in office or home.

Industrial applications of microprocessors require highly skilled two-year postsecondary graduates in order to maintain highly sophisticated industrial equipment. But some customer applications, such as television games and pinball machines that use basic simple microprocessor systems need only trained personnel from one-year development programs for their maintenance.

Vocational/Technical Education as a Supplier of Microprocessor Related Technicians

A two-year postsecondary course in the junior college or technical institute provides the best academic background for digital technicians.* The military services have represented another method for training digital technicians, but the quantity of service trainees has steadily decreased since the draft's abolishment.

At the present time, to meet increasing needs for digital technicians, computer manufacturers have been reduced to hiring anyone with a basic understanding of electronics (such as television service personnel and electronic hobbyists) and then giving them on-the-job training. With so much of the economy employing microprocessors as a control element, the need for digital technicians can only grow at a steady and sustained rate.

Industrial technicians need a two-year postsecondary program in electronics. Their training must stress analytical thought and a firm foundation in basic and digital electronics with an emphasis on semiconductor devices and integrated circuits. They must also be able to use basic hand tools, soldering equipment, and a variety of test equipment such as voltmeters, ohmmeters, logic probes, and logic analyzers. Finally, they should be knowledgeable in basic microprocessor programming techniques--in other words, with microprocessor hardware and software.

* Since the microprocessor is a small device used in digital electronic applications, this writer chooses to use the term digital technician in place of microprocessor technician.

Technicians who service television games need approximately one year's training in basic and digital electronics. They use small hand tools such as screwdrivers, nutdrivers, and wire-strippers. They must possess good soldering techniques and be able to use basic electronic test equipment such as voltmeters, ohmmeters, logic probes, and oscilloscopes in order to check component failures.

A Microprocessor Survey

This writer wished to determine the specific requirements of the electronics industry in the State of Texas for microprocessor system training in order to update curricula. A survey was designed to collect the opinions of electronics employers regarding skill requirements for entry level digital technicians.

Instrumentation. A task inventory was prepared from microprocessor materials that consisted of 121 items covering the topics of microprocessors and computer hardware (see Appendix C-2). A four point Likert Scale was used with each task item. The scale was "Taught in Depth," "Emphasize," "Discussed Briefly," and "Not Taught." This type of scale was chosen along with an instrument format because a previous study had used a similar format (Wright, 1969). A score of 4.0 was assigned to "Taught in Depth," 3.0 assigned to "Emphasized," 2.0 assigned to "Discussed Briefly," and 1.0 assigned to "Not Taught." A priority ranking for each task item could be determined according to the mean responses.

Survey participants. The placement list for the Electronics Technology program with 400 industrial ogranizations was the population base. This population is probably representative of the state in terms of those businesses employing program graduates. Of the 400 companies receiving the survey, 129 responded. Each industry was asked to characterize its primary purpose in one of six categories: Research and Development, Electronic Communications, Computers, Manufacturing, Oil Related, and Other. The distribution of responses by category was: Research and Development, 22; Electronic Communications, 18; Computers, 22; Manufacturing, 31; Oil related, 23; and Other, 13.

Findings. The relative importance of each of the 121 task items for inclusion within an electronics curriculum was determined by the mean score for each item. The higher the score (a possible range of 1.0-4.0), the more importance the employers placed on the specific item being emphasized in a training program. The highest priority factor (mean score) attained by any item was 3.6, and the lowest was 2.0.

Figure 3 shows a graph of frequency distribution versus priority factor. The mean for all items combined was 2.7, and the standard deviation was 0.7. Appendix C-3 provides the compilation of results for the 121 items.

The mean of all microprocessor related items was 3.2. The mean for all items relating to hardware for microprocessors was above 3.0. A mean of 2.7 implies an approximate "Emphasize" for all computer hardware.

To determine the importance of various test equipment, each industrial respondent listed the three most important pieces of test equipment that electronics technicians need. The top three instruments were volt-ohm-millameters (V.O.M.), digital multimeters, and logic analyzers. It is worth noting that logic analyzers are products of the microprocessor revolution and incorporate microprocessors as their brain in order to test and trouble shoot microprocessor systems. This is a further indication of the importance industry places on the microprocessor.

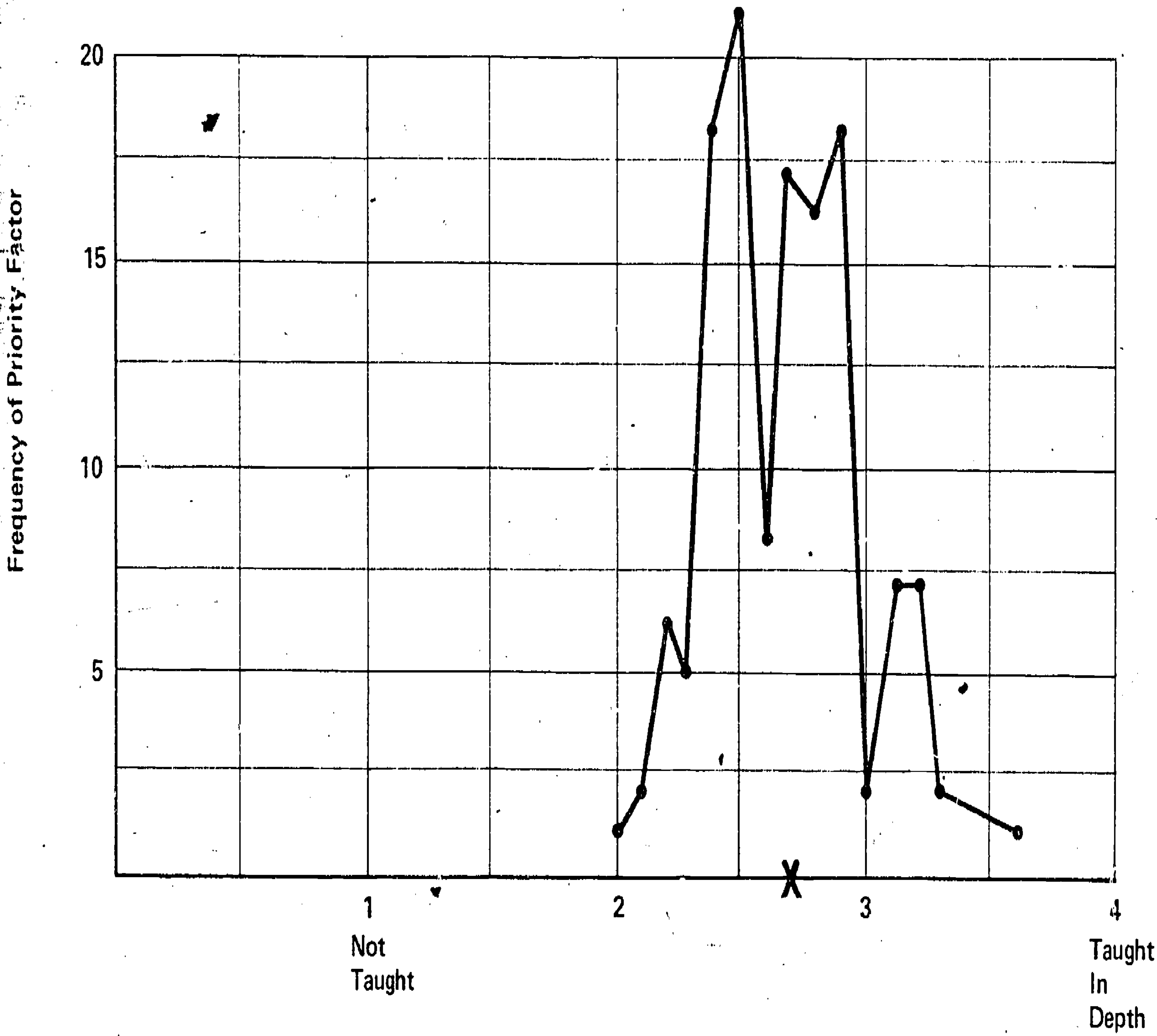
As a result of the survey, this writer incorporated three microprocessor courses into the curriculum. Nevertheless, a good curriculum must contain basic electronics courses in order to train students in the concepts necessary for microprocessor and digital techniques.

Implications for Vocational/Technical Instructional Development

Just eight years ago, the microprocessor revolution started. Many teachers in vocational/technical education have been teaching for ten or more years and obviously do not possess microprocessor experience. The need to update vocational teachers is urgent. Today there are many microprocessor workshops which usually last for a week. Unfortunately, most are during the fall and spring and demand a tuition of $700 (plus room, board, and transportation). Thus, the cost to teachers is extremely high, and these courses occur when it is difficult for them to get away from their work.

This writer believes that there is a need for microprocessor training materials that would update teachers technical skills for their work in classrooms and laboratories with students. At the present time instructional development of teachers is almost as important a need as the need for more qualified technicians. Qualified teachers are also in demand and difficult to find. However, the requalification of those teachers in the field is essential.

Figure 3: Frequency Distribution of Priority Factors for Microprocessor System Training



Note: X=mean

Priority Factor

References

Electronics, The International Magazine of Electronics Technology, McGraw Hill, October 14, 1968, page 193.

Larsen, David G.; Rony, Peter, R.; and Titus, Jonathan A. The Bugbook III Microcomputer Interfacing, Derby: E & L Instruments, Inc., 1975.

Larsen, David G., Rony, Peter R., and Titus, Jonathan A. Introductory Experiments in Digital Electronics and 8080A Microcomputer Programming and Interfacing--Book 2. Indianapolis: Howard W. Sams & Co., Inc., 1978.

Occupational Outlook Handbook. U.S. Department of Labor, Bureau of Labor Statistics Bulletin 1955. U.S. Government Printing Office, 1978-79 Edition, page 418.

Roland, Jon. "The Microelectronic Revolution. How Intelligence on a Chip will Change our Lives." The Futurist, April,1979, pp. 81-90.

Wright, Jerauld B. An Investigation into Public Post-Secondary Electronic Technology Programs in Texas with Implications for Planning. Texas Education Agency, 1969.

CHAPTER IV

CONCLUSIONS

This study aims to provide information to national vocational education policy-makers on curriculum development needs for new and changing occupations. Based on the information obtained from working on this study for two consecutive years, some conclusions can be drawn both about curriculum development needs for identified occupations and about methodology used to identify those occupations. Conclusions appear in the order used in the methodology, beginning with the preliminary identification of new and changing occupations. Conclusions regarding curriculum development needs for identified occupations appear last.

Methodology

No single source of projections for new or changing occupations exists. Available projections can, however, identify established occupational areas with projected high growth rates. These occupational areas could be a source of growth of new occupations. This circumstance occurred in the first year of the study in the health technician field and in Year II of the study with science technicians.

A national project on new or changing occupations cannot include occupations that develop at regional, state, or local levels. However, occupations that are national may not have application to a given region, state, or locale. Prior to implementation of a new program, a needs study should be initiated. Involvement by an advisory committee of business, industry, and labor leaders, as well as educators, has proven to be desirable and effective in conducting needs studies and implementing new programs.

Designation of new occupations is difficult, particularly if similar tasks are handled by existing occupations. Jurisdictional questions arise, particularly if training occurs, at least in part, through apprenticeship programs. This question appears in the solar energy field and in construction duties for housing rehabilitation specialists.

Telephone contact with employers, educators, and professional organizations proved to be a very valuable method of obtaining current information on given occupations.

The military is a limited source of curricula for new or changing occupations. The only curriculum that related to occupations identified in the second year of the study was the laser curriculum. That occurred at the graduate level and dealt primarily with weaponry. Due to its "classified" status, it was not reviewed. In the past, however, some new occupations have originated in the military and spread to the civilian sector. An example is the biomedical equipment technician. Therefore, the military should continue to be reviewed as possible sources for curricula.

Computer searches for curricula on identified occupations are worthwhile. The project staff felt, however, that some curricula were not listed. This gap implies the inaccessibility of curricula, a point to be considered in a curriculum development process.

Curriculum Development Needs

The project staff found that the range of curriculum development required for the identified occupations varied along a continuum from reorganization of existing curricula for new programs to the development of entire two-year program outlines and curricula. Curriculum development needs for occupations are discussed in the following paragraphs.

Tumor Registrar

Much curriculum needs to be developed for topics outlined by the National Tumor Registrar Association. Few materials are now available. The curriculum could be incorporated into medical records technician programs, with tumor registrar as a speciality area.

Housing Rehabilitation Specialist

Curriculum development for housing rehabilitation specialists could be accomplished, for the most part, by combining construction and finance courses to form a new program. It may also be advisable to include some public administration courses since the occupation exists primarily in the public sector. Some limitations in construction areas exist because of apprenticeship requirements in trades areas.

Laser/Electro-Optics Technician (LEOT)

The laser/electro-optics technician curriculum needs to be updated. New modules should be developed, and several existing modules should be deleted. Because of technological advances in laser capability and application, training materials must remain current for the education to be useful. A conference of LEOT employers and educators in early 1980 will identify necessary changes in curriculum.

Case Manager

In response to legislation deinstitutionalizing mentally ill and mentally retarded clients, the role of social services personnel in the community has expanded. This is due to new surroundings and needs of clients. Extensive curriculum development will be required for the new and changing responsibilities of case managers in these fields. Curriculum can be offered in conjunction with existing mental health or mental retardation programs.

Microprocessing Related Occupations

Microprocessing courses need to be integrated in the regular two-year electronics curriculum or a one-year certificate program. Although the Solomon research indicates those areas that need emphasis in Texas, a nationwide study is needed. There is also a need for faculty development in microprocessing.

Energy Related Occupations

Curriculum development in energy occupations is specific to the individual energy industry. Other factors such as organized labor and local considerations are important to assess the need for curriculum and educational programs.

Construction. Shortages of electricians, pipefitters, boilermakers, welders, and carpenters may affect the efficiency with which America changes its energy sources. Occupational preparation for these jobs has been traditionally handled by union apprenticeship programs. Unless organized labor feels vocational education can prepare construction workers, it may be difficult for vocational institutions to successfully implement educational programs in the field.

Coal mining and transportation. Safety training for coal miners has now been legislated. Vocational education has handled this role successfully in a number of locales. Each curriculum must be appropriate to the specific mine and areas where the trainees will be working.

Oil and Gas. A 50 percent growth in oil and gas extraction is predicted. There are currently fifteen vocational schools and community colleges training in this area, and employers increasingly look to vocational education as a source for their workers. Although oil and gas occupations are not new, comprehensive curricula material has not been systematically gathered.

Nuclear. Fewer than 100 of all nuclear plant employees have two-year degrees in nuclear technology. TERC has developed a curriculum,and local schools have also accomplished curriculum development. Unless an individual school has a strong commitment from a nearby company or utility to employ graduates, a new program probably should not be initiated. Adequate curriculum materials are available.

Solar. The solar flat plate collector industry expects to grow and create jobs. Appropriately designed vocational education programs are a good source of prepared applicants for this industry. It is important that educators and employers compare requirements and offerings often in this field because of rapid changes.

Conservation. The need to conserve energy is growing in both residential homes and large public and commercial buildings. Employment in this field has been delayed, however, due to several considerations. Skills required for individuals who will conduct energy audits have not been determined. Educational programming needed initially will probably aim to upgrade current employees who will add energy conservation tasks to their job description.

APPENDICES

APPENDIX A

PROJECT CONSULTANTS

Consultant Review Panel

1. Mr. Max Carey
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   Bureau of Labor Statistics
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3. Dr. Maurice Roney, President
   Texas State Technical Institute
   Waco, Texas 76705

4. Mr. Jeff Windom
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Final Report External Reviewers

1. Dr. James B. McCord
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   National Occupational Information
   Coordinating Committee
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   Washington, D.C. 20202

APPENDIX B

LIST OF OCCUPATIONS WHICH WERE OUTSIDE THE SCOPE OF YEAR II STUDY

Established Occupations

Alcoholism Counselor
Avionics/Flight Technology
Ballistician
Chemical Laboratory Assistant
Data Processing Machine Repairers
Dental Assistant
Dental Laboratory Technician
Diagnostic Radiologic Technician
Dietary Technician
Electrocardiograph Technician
Emergency Medical Technician
Encephlograph Technician
Foremanship Related
Opthalmic Medical Assistant
Heat and Power Engineer
Histologic Technician
Historical Preservation Interpreter
Inhalation Therapist
Medical Office Assistant
Medical Records Technician
Municipal Waste Disposal
Nursing Assistant, Aide
Optical Technologist
Opticianry Technician
Optometric Assistant/Technician
Orthotic & Prosthetic Assistant/Technologist
Para-Accountant
Para-professional Optometrist
Pest Management Related
Pin Ball and Vending Machine Repairers
Public Health Technology
Public Safety Communication Officer
Railroad Related
Standards and Calibration Technician
Tissue Culture Technician
Cyto Technology Technician
Wastewater Treatment Plant Operator or Technician

National Center Year I Occupations

Aging Specialist
Air Pollution Technician
Cardio Pulmonary Technician
Clinical Arrival Technician
Diagnostic Medical Sonographer
Dialysis Technician
Nephrology Assistant
Environmental Engineering Aide
Environmental Health Related
Environmental Technician
Health Service Management Assistant
Homemaker--Home Health Aide
Industrial Hygiene Technician
Noise Abatement Technician
Long Term Health Care Technician
Medical Laboratory Assistant
Multi-Competency Technician
Nursing Home Administrator
Operating Room (Surgical) Technician
Physician's Assistant
Theraputic Recreation Technician

Occupations with Task Analysis or Curriculum Development Recently Completed or Currently Underway

Bio-Medical Equipment Technician
Commercial River Transportation
Cultural Resources Technician
Electrodiagnostic Technician
Electro Mechanical Technician
Equine Management
Extracorporeal Circulatory Technician
Farriering
Forest Recreation Technician
Foundry Technology Related
Geo-Urban Planning and Administration
Horology
Hydrology Technology Related
Indoor-Environmental Technology
Industrial Chemistry Technology
Instrumental Technician
Library Technician
Medical Electronics Engineering Technology
Music Equipment Repair Technology
Nuclear Medicine Technologist
Oceanography Specialist
Para-Legal
Pediatric Assistant
Pedology
Photo-Jewelry Technology Related
Postal Management Related
Respiratory Therapist
Safety/Risk Management
Ultra Sound & Thermography Related
Visitor Industry Entertainers

Related Studies' Occupations with Insufficient Demand

Airport Security Officer
Cable TV Technology Related
Certified Fertilizer Applicator
Chemical Spill Control Technician
Chromotography Technician
Computer Tape Librarian
Chrystal Manufacturing Related
Fundus Photographer
Holographic Technician
Horticulture Therapy Assistant
Media Equipment Technician
Medical Institution Safety Technician
Midwife
Occupational Therapy Assistant
Physical Security Technician
Physical Therapy Assistant
Podiatric Assistant
Pyrolysis Technician
Radiation Protection Technician
Recoverable Materials Coordinator
Sediment Control Inspector
Veterinary Assistant Technician

Related Studies' Occupations with Educational Requirements Beyond the Scope of Vocational Education

Anesthesiologist Assistant
Child Advocate
Communication Aide
Community Development Officer
Data Communications Manager
Horticulture Therapist
Industrial Laboratory Assistant
Kerlian Photographer
Mineral Exploration Technician
Para Medic Forensic Scientist
Pharmacy Aide
Profusionist
School Health Aide

APPENDIX C

MICROPROCESSOR APPENDICES

C-1 Microprocessor Manufacturers

C-2 Microprocessor Task Analysis Questionnaire

C-3 Task Analysis Survey Compilation

MICROPROCESSOR MANUFACTURERS

American Micro-Systems, Inc.
3800 Homestead Road
Santa Clara, CA 95051

Burroughs Corporation
Defense, Space & Special Systems Group
Paoli, PA 19301

Electronic Arrays, Inc.
550 Middle Field Road
Mountain View, CA 94043

Fairchild Semiconductor
313 Fairchild Drive
Mountain View, CA 94040

General Instruments Corporation
Microelectronics Division
600 W. John Street
Hickville, NY 11802

Inselek
743 Alexander Road
Princeton, NJ 08540

Intel Corporation
3065 Bowers Avenue
Santa Clara, CA 95051

Intersil
10900 Tantav Avenue
Cupertine, CA 95014

Microsystems International, Ltd.
75 Moodie Drive
Ottawa, Ontario
Canada K1Y4J1

Monolithic Memories, Inc.
1165 E. Arques Avenue
Sunnyvale, CA 94086

Mostex
1215 W. Crosby Road
Carrollton, TX 75006

Motorola Semiconductor
Box 20912
Phoenix, AZ 85036

National Semiconductor Corporation
2900 Semiconductor Drive
Santa Clara, CA 95051

Ratheon Company
Semiconductor Division
350 Ellis Street
Mountain View, CA 94042

RCA Corporation
Solid State Division
Sommerville, NJ 08776

Rockwell International
Microelectronics Device Division
3310 Miraloma Avenue
Anahiem, CA 92803

Signetics Corporation
811 E. Arques Avenue
Sunnyvale, CA 94086

Tokyo Shibaura Electric Company
1, Komukai Toshibacho
Kawasaki - City
Kanaquawa, 210, Japan

Transitron Electronic Corporation
168 Albion Street
Wakefield, MA 01880

Western Digital Corporation
19242 Red Hill Avenue
Newport Beach, CA 92663

APPENDIX C-2

MICROPROCESSOR TASK ANALYSIS QUESTIONNAIRE

HOW TO FILL OUT THIS QUESTIONNAIRE

The objective of this questionnaire is to determine entry level requirement for digital electronics into your industry for electronic technicians. Please read the directions carefully to help you provide proper response in the multiple columns.

After each instructional item, please check (✓) one of the four columns to indicate the degree of teaching emphasis you think the item should be given. Choose one of the four columns according to the definitions in the table below.

EGREE OF MPHASIS	Definitions of headings on columns in terms of: Teacher Effort	Objectives	Lab Time	Student Responsibility
AUGHT IN EPTH	Complete, detailed instruction, including all related information	Student will develop a complete understanding, including ability to apply the knowledge in practical situations	One or more lab sessions related to the topic	Student realizes this is very important material
MPHASIZED	Class discussion devoted specifically to this topic	Student will develop a general knowledge, although not necessarily a high degree of skill in applying the knowledge in any situation	Topic included in laboratroy practice	Student realizes this is important material
ISCUSSED RIEFLY	Mentioned or discussed briefly in one or two class sessions	Student will develop a familiarity with terms and general ideas concerning the topic	Topic may be encountered while doing lab work	Student realizes this material is not too important
OT TAUGHT	May be mentioned incidentally or possibly not at all	Topic is not included in the objectives for the course	No lab practice	Student realizes this material is not important

If you don't agree exactly with any of the definitions, choose the one that most closely agrees with your definition and comment to us your variation.

COMMENTS:

Please fill in the following information concerning your industry.

1. Industrial Purpose

   a. Research and Development ______________

   b. Electronic Communications ______________

   c. Computers ______________

   d. Manufacturing ______________

   e. Oil Related ______________

   f. Other ______________

2. What three items of trouble shooting equipment should electronic techn cians you employ be most skilled in operating?

   ______________ ______________ ______________

3. Company's Name ______________

   Address ______________

4. Name of person answering questionnaire ______________

   Position ______________

MICROPROCESSORS	Taught in Depth	Emphasized	Discussed Briefly	Not Taught
Basic Architectures				
Instructional Formats				
Fetching Sequence T_1, T_2, T_3, etc.				
Flags				
System Chips				
Clock Chip				
Status Controllers				
RAM				
ROM				
Core Memories				
Programmable I/O				
Latches				
Drivers				
Programmable Timers				
Programmable Interrupt Controls				
Direct Memory Access Controls				
MODEM				
PROM				
Device Controls, (Disk, Key-board, Display, Printer)				
EPROM				
CCD Memories				
PLA				
EAROM				
Microprocessor Programming				
Basic Arithmetic Operation				
I/O Addressing				
Interrupts				
Timing Loops				
Code Conversion				
Troubleshooting				
Logic Problems				
Signature Analysis				
Emulation				
Simulation				
Logic State Analyzers				
Mapping Analysis				

INTERFACING THE PERIPHERALS	Taught in Depth	Emphasized	Discussed Briefly	Not Taught
Input-Output Addressing				
Special I/O Instructions				
Memory-Mapped I/O				
I/O Techniques				
Programmed I/O or Polling				
Interrupt Driven I/O				
DMA Technique				
Digital to Analog Converter Techniques				
Binary-Weighted Resistor D/A				
Binary-Weighted R-2R D/A				
Current-Fed D/A				
Multiplying D/A				
Analog to Digital Converters				
Capacitor-Charging A/D				
Voltage to Frequency ADC				
Pulse Width Modulator ADC				
Single Slope (Ramp) ADC				
Dual-Slope Integrating ADC				
Charge-Balancing ADC				
Quad-Slope Integration				
Descrete Voltage Comparison ADC				
Counter Ramp ADC				
Continuous Ramp ADC				
Successive-Approximation ADC				
Simultaneous (Parallel) ADC				
Sample and Hold Circuits				
Analog Multiplexers				
Digital Multiplexers				
Keyboards				
Non-Encoded Keyboard				
Software Delay				
Rollover				
Two-Key Rollover				
N-Key Rollover				
N-Key Lockout				
Linereversal Techniques				

Topic	Taught in Depth	Emphasized	Discussed Briefly	Not Taught
Encoded Keyboard				
Keyboard Encoders				
Scanning Chips				
ASCII Keyboards				
UARTs				
LED Displays				
Seven Segment				
Multiplexing LEDs				
Matrix LEDs				
LCDs				
Teletype				
RS232				
Optical Isolators				
UART Timing				
I/O Subroutines				
Cassette Interface				
Kansas City Standard				
IC Controllers				
CRT Display Interface				
Timing Problems				
Character Generators				
Raster Generation				
CRT Controllers				
Intelligent CRT				
Floppy Disk				
Formatting (Basic)				
Hard-Sectoring				
Soft-Sectoring				
Floppy Disk Drives Operation				
Accessing the Track				
Reading and Writing				
Disk Drive Signals				
Motor On				
Direction Select				
Step				
Write Gate				
Track 00				
Index/Sector				

Topic	Taught in Depth	Emphasized	Discussed Briefly	Not Taught
Floppy Disk cont.				
Status Signals				
Ready I				
Index				
Write-Protect				
Cyclic Redundancy Check				
Controller Chips				
Dynamic Ram Refresh				
Burst Mode				
Distributed or Single-Cycle Mode				
Refresh Controller Chips				
Asynchronous Access				
Hidden Refresh				
Bus Standard				
S-100				
IEEE-488				
IEEE-583 CAMAC				
EIA - RS232C				
EIA - RS422, RS423				
ASCII Information Standard				
Interface Circuits				
UART - Programmable Communication Interface				
PIO - Programmable I/O Port				
DMAC - Direct Memory Access Controller				
PIC - Programmable Interrupt Controller				
PIT - Programmable Interval Timer				
PIA - Peripheral Interface Adapter				
Other				

Comments____

TASK ANALYSIS SURVEY

COMPILATION

1978-1979

ELECTRONICS TECHNOLOGY

TEXAS STATE TECHNICAL INSTITUTE

1978 - 1979 TASK ANALYSIS SURVEY

ELECTRONIC TECHNOLOGY

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 1 Basic Architectures					
Research and Development	11	4	3	0	18
Electronic Communications	10	4	3	1	18
Computers	9	7	3	2	21
Manufacturing	13	10	8	0	31
Oil Related	9	10	3	0	22
Other	4	6	2	0	12
Priority Factor 3.2					
TOTAL	56	41	22	3	122
Task No. 2 Industrial Formats					
Research and Development	5	8	6	0	19
Electronic Communications	8	7	2	2	19
Computers	7	7	4	3	21
Manufacturing	6	15	9	1	31
Oil Related	8	12	2	0	22
Other	2	8	2	0	12
Priority Factor 2.9					
TOTAL	36	57	25	6	124
Task No. 3 Fetching					
Research and Development	6	6	3	2	17
Electronic Communications	4	6	9	2	21
Computers	4	6	9	2	21
Manufacturing	5	13	13	0	31
Oil Related	4	14	4	0	22
Other	2	7	3	0	12
Priority Factor 2.8					
TOTAL	25	52	41	6	124
Task No. 4 Flags					
Research and Development	5	7	5	2	19
Electronic Communications	4	7	5	2	18
Computers	5	6	7	3	21
Manufacturing	5	12	14	0	31
Oil Related	8	10	4	0	22
Other	2	6	4	0	12
Priority Factor 2.8					
TOTAL	29	48	39	7	123
Task No. 5 Clock Chips					
Research and Development	5	7	7	0	19
Electronic Communications	5	8	4	1	18
Computers	6	5	9	2	22
Manufacturing	7	13	11	0	31
Oil Related	9	3	9	0	21
Other	5	5	3	0	13
Priority Factor 2.9					
TOTAL	37	41	43	3	124
Task No. 6 Status Controllers					
Research and Development	5	5	8	1	19
Electronic Communications	4	10	3	1	18
Computers	5	6	7	2	20
Manufacturing	7	11	13	0	31
Oil Related	7	8	6	0	21
Other	4	5	4	0	11
Priority Factor 2.9					
TOTAL	32	45	41	4	122

ELECTRONIC TECHNOLOGY

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 7 RAM					
Research and Development	8	8	3	0	19
Electronic Communications	5	7	4	1	17
Computers	8	9	4	1	22
Manufacturing	12	16	3	0	31
Oil Related	13	8	2	0	23
Other	8	2	3	0	13
Priority Factor 3.3					
TOTAL	54	50	19	2	125

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 8 ROM					
Research and Development	8	9	2	0	19
Electronic Communications	5	7	4	1	17
Computers	8	9	4	1	22
Manufacturing	11	16	4	0	31
Oil Related	12	8	3	0	23
Other	8	2	4	0	14
Priority Factor 3.2					
TOTAL	52	51	21	2	126

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 9 Core Memories					
Research and Development	0	6	12	1	19
Electronic Communications	1	6	9	1	17
Computers	2	4	11	5	22
Manufacturing	0	10	18	2	30
Oil Related	4	7	11	2	24
Other	3	2	6	1	12
Priority Factor 2.5					
TOTAL	10	35	67	12	124

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 10 Programmable I/O					
Research and Development	8	6	5	0	19
Electronic Communications	5	8	4	1	18
Computers	6	9	5	1	21
Manufacturing	7	16	7	0	30
Oil Related	10	9	3	0	22
Other	7	3	2	1	13
Priority Factor 3.1					
TOTAL	43	51	26	3	123

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 11 Latches					
Research and Development	5	5	4	0	14
Electronic Communications	9	7	7	0	23
Computers	7	8	7	0	22
Manufacturing	10	14	7	0	31
Oil Related	9	7	7	0	23
Other	5	5	4	0	14
Priority Factor 3.1					
TOTAL	45	46	36	0	127

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 12 Drivers					
Research and Development	7	5	7	0	19
Electronic Communications	6	6	5	1	18
Computers	7	7	7	0	21
Manufacturing	13	13	5	0	31
Oil Related	9	7	7	0	23
Other	6	4	3	0	13
Priority Factor 3.1					
TOTAL	48	42	34	1	125

1978 - 1979 TASK ANALYSIS SURVEY

ELECTRONIC TECHNOLOGY

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 13 Programmable Timers					
Research and Development	4	8	6	1	19
Electronic Communications	3	8	6	1	18
Computers	4	6	11	1	22
Manufacturing	5	14	12	0	31
Oil Related	7	10	6	0	23
Other	4	4	4	0	12
Priority Factor 2.8					
TOTAL	27	50	45	3	125

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 14 Programmable Interrupt Controls					
Research and Development	7	7	4	1	19
Electronic Communications	2	9	6	1	18
Computers	5	7	9	0	21
Manufacturing	7	16	9	0	32
Oil Related	7	11	4	0	22
Other	6	3	5	0	14
Priority Factor 2.9					
TOTAL	34	53	37	2	126

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 15 Direct Memory Access Contr					
Research and Development	8	6	4	1	19
Electronic Communications	4	9	4	1	18
Computers	9	7	5	0	21
Manufacturing	5	17	7	1	30
Oil Related	12	7	3	1	23
Other	5	4	4	0	13
Priority Factor 3.1					
TOTAL	43	50	27	4	124

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 16 MODEM					
Research and Development	1	9	7	2	19
Electronic Communications	7	6	5	1	19
Computers	4	8	6	3	21
Manufacturing	3	11	10	1	25
Oil Related	1	9	5	0	15
Other	4	5	5	0	14
Priority Factor 2.7					
TOTAL	20	48	38	7	113

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 17 PROM					
Research and Development	4	9	7	2	22
Electronic Communications	2	8	7	1	18
Computers	7	7	6	5	22
Manufacturing	8	18	5	0	31
Oil Related	8	11	4	0	23
Other	4	4	5	0	13
Priority Factor 3.2					
TOTAL	33	57	34	5	129

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 18 Device Controls					
Research and Development	4	8	6	1	19
Electronic Communications	3	7	7	1	18
Computers	7	7	5	2	21
Manufacturing	7	17	8	0	32
Oil Related	8	10	4	0	22
Other	4	6	3	0	13
Priority Factor 2.9					
TOTAL	33	55	33	4	125

ELECTRONIC TECHNOLOGY

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 19 EPROM					
Research and Development	5	7	6	1	19
Electronic Communications	3	7	7	1	18
Computers	4	5	7	4	20
Manufacturing	8	13	10	1	32
Oil Related	7	10	6	0	23
Other	1	3	8	0	12
Priority Factor 2.3					
TOTAL	28	45	44	7	124
Task No. 20 CCD Memorics					
Research and Development	0	6	12	1	19
Electronic Communications	0	7	9	1	17
Computers	1	4	9	5	19
Manufacturing	0	9	20	2	31
Oil Related	4	2	10	1	24
Other	1	2	9	0	12
Priority Factor 2.3					
TOTAL	6	37	69	10	122
Task No. 21 PLA					
Research and Development	1	5	11	2	19
Electronic Communications	0	6	10	1	17
Computers	1	3	9	6	19
Manufacturing	0	6	22	4	32
Oil Related	3	4	12	1	20
Other	2	2	8	0	12
Priority Factor 2.2					
TOTAL	7	26	72	14	119

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 22 EAROM					
Research and Development	2	4	11	2	19
Electronic Communications	1	6	9	1	17
Computers	6	13	2	1	22
Manufacturing	0	9	20	4	33
Oil Related	6	7	9	0	22
Other	1	3	8	0	12
Priority Factor 2.5					
TOTAL	16	42	59	8	125
Task No. 23 Basic Arithmetic Operatio					
Research and Development	6	11	2	0	19
Electronic Communications	6	8	3	2	19
Computers	6	13	2	1	22
Manufacturing	13	14	4	0	31
Oil Related	9	11	2	1	23
Other	4	10	0	0	14
Priority Factor 3.2					
TOTAL	44	67	13	4	128
Task No. 24 I/O Addressing					
Research and Development	10	7	2	0	19
Electronic Communications	11	3	3	2	19
Computers	7	10	4	1	22
Manufacturing	10	17	4	0	31
Oil Related	12	8	1	1	22
Other	5	6	2	0	13
Priority Factor 3.2					
TOTAL	55	51	16	4	126

ELECTRONIC TECHNOLOGY

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 25 Interrupts					
Research and Development	11	3	4	1	19
Electronic Communications	10	3	4	2	19
Computers	9	6	5	2	22
Manufacturing	9	10	11	1	31
Oil Related	12	8	1	1	22
Other	3	8	2	0	13
Priority Factor 3.2					
TOTAL	54	38	27	7	126

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 26 Timing Loops					
Research and Development	5	11	3	0	19
Electronic Communications	5	7	4	2	17
Computers	4	8	8	2	22
Manufacturing	5	13	12	0	30
Oil Related	6	14	2	1	23
Other	5	5	3	0	13
Priority Factor 2.9					
TOTAL	30	57	32	5	124

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 27 Code Conversion					
Research and Development	4	10	5	0	19
Electronic Communications	6	6	4	2	18
Computers	3	6	11	2	22
Manufacturing	9	12	9	0	30
Oil Related	7	11	4	1	23
Other	5	6	3	0	14
Priority Factor 2.9					
TOTAL	34	51	36	5	126

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 28 Logic Problems					
Research and Development	15	3	0	1	19
Electronic Communications	9	4	4	1	18
Computers	19	3	0	0	22
Manufacturing	25	5	1	0	31
Oil Related	18	5	1	0	24
Other	12	2	0	0	14
Priority Factor 3.6					
TOTAL	98	22	6	2	128

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 29 Signature Analysis					
Research and Development	5	7	6	1	19
Electronic Communications	9	4	4	1	18
Computers	6	7	5	4	22
Manufacturing	6	14	8	2	30
Oil Related	6	10	7	1	24
Other	6	4	3	1	14
Priority Factor 2.9					
TOTAL	38	46	33	10	127

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 30. Emulation					
Research and Development	4	8	5	2	19
Electronic Communications	7	3	6	2	18
Computers	3	6	8	3	20
Manufacturing	5	13	11	1	30
Oil Related	5	6	11	0	22
Other	2	7	2	2	13
Priority Factor 2.7					
TOTAL	26	43	43	10	122

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UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 31 Simulation					
Research and Development	4	9	5	1	19
Electronic Communications	6	6	5	1	18
Computers	3	9	7	2	21
Manufacturing	2	15	14	1	32
Oil Related	4	8	10	0	22
Other	4	6	3	0	13
Priority Factor 2.8					
TOTAL	23	53	44	5	125
Task No. 32 Logic State Analyzers					
Research and Development	11	6	1	1	19
Electronic Communications	8	5	4	1	18
Computers	12	8	2	1	23
Manufacturing	15	8	7	1	31
Oil Related	13	7	3	0	23
Other	9	3	1	1	14
Priority Factor 3.3					
TOTAL	68	37	18	5	128
Task No. 33 Mapping Analysis					
Research and Development	5	5	7	2	19
Electronic Communications	4	5	5	2	16
Computers	7	4	8	2	21
Manufacturing	4	10	15	2	31
Oil Related	6	6	7	3	22
Other	4	5	3	1	13
Priority Factor 2.7					
TOTAL	30	35	45	12	122

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 34 Special I/O Instructions					
Research and Development	7	8	3	1	19
Electronic Communications	7	5	4	2	18
Computers	9	5	5	3	22
Manufacturing	8	18	5	0	31
Oil Related	9	9	4	1	23
Other	6	2	4	1	13
Priority Factor 3.0					
TOTAL	46	47	25	8	126
Task No. 35 Memory-Mapped I/O					
Research and Development	7	9	1	2	19
Electronic Communications	7	6	2	3	18
Computers	5	10	3	4	22
Manufacturing	4	19	6	2	31
Oil Related	6	11	5	1	23
Other	6	2	3	2	13
Priority Factor 2.9					
TOTAL	35	57	20	14	126
Task No. 36 Programmed I/O or Polling					
Research and Development	8	8	3	1	20
Electronic Communications	8	8	0	2	18
Computers	4	11	3	1	19
Manufacturing	7	15	8	1	31
Oil Related	9	13	0	0	22
Other	4	6	2	0	12
Priority Factor 3.[illegible]					
TOTAL	40	61	16	5	122

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UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 37 Interrupt Driven I/O					
Research and Development	9	4	6	0	19
Electronic Communications	7	8	1	2	18
Computers	7	8	5	1	21
Manufacturing	9	13	9	0	31
Oil Related	9	13	0	0	22
Other	4	7	2	0	13
Priority Factor 3.1					
TOTAL	45	53	23	3	124
Task No. 38 DMA Technique					
Research and Development	8	6	4	1	19
Electronic Communications	5	10	1	2	18
Computers	6	8	4	3	21
Manufacturing	6	16	9	0	31
Oil Related	6	11	5	0	22
Other	5	5	2	1	13
Priority Factor 2.9					
TOTAL	36	56	25	7	124
Task No. 39 Binary-Weighted ResistD/A					
Research and Development	2	7	9	1	19
Electronic Communications	1	9	6	2	18
Computers	3	9	8	2	22
Manufacturing	2	15	14	0	31
Oil Related	5	8	10	0	23
Other	4	2	6	1	13
Priority Factor 2.6					
TOTAL	17	50	53	6	126

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 40 Binary-Weighted R-2R D/A					
Research and Development	4	5	9	1	19
Electronic Communications	2	7	7	2	18
Computers	4	6	9	3	22
Manufacturing	4	14	12	0	30
Oil Related	8	7	8	0	23
Other	4	2	6	1	13
Priority Factor 2.7					
TOTAL	26	41	51	7	125
Task No. 41 Current-Fed D/A					
Research and Development	2	6	8	3	19
Electronic Communications	3	6	6	3	18
Computers	5	4	7	6	22
Manufacturing	4	8	16	3	31
Oil Related	7	7	9	0	23
Other	4	2	6	1	13
Priority Factor 2.5					
TOTAL	25	33	52	16	126
Task No. 42 Multiplying D/A					
Research and Development	1	7	8	3	19
Electronic Communications	1	8	6	3	18
Computers	3	8	5	6	22
Manufacturing	3	11	15	2	31
Oil Related	6	10	7	0	31
Other	4	3	5	1	
Priority Factor 2.5					
TOTAL	18	47	46	15	126

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UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 43 Capacitor-Charging A/D					
Research and Development	2	8	7	2	19
Electronic Communications	1	8	7	2	18
Computers	3	10	7	2	22
Manufacturing	3	12	14	1	30
Oil Related	4	12	5	1	22
Other	2	5	3	1	11
Priority Factor 2.6					
TOTAL	15	55	43	9	122
Task No. 44 Voltage to Frequency ADC					
Research and Development	0	9	8	2	19
Electronic Communications	2	8	6	2	18
Computers	4	5	9	4	22
Manufacturing	3	11	15	2	31
Oil Related	5	12	5	1	23
Other	4	4	5	1	14
Priority Factor 2.6					
TOTAL	18	49	48	12	127
Task No. 45 Pulse Width Modulator ADC					
Research and Development	0	9	9	1	19
Electronic Communications	1	7	8	2	18
Computers	3	6	10	3	22
Manufacturing	3	9	18	1	31
Oil Related	3	10	9	1	23
Other	3	4	6	1	14
Priority Factor 2.5					
TOTAL	13	45	60	9	127

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 46 Single Slope (Ramp) ADC					
Research and Development	0	7	10	2	19
Electronic Communications	2	7	7	2	18
Computers	3	9	6	4	22
Manufacturing	3	11	16	2	32
Oil Related	4	12	6	1	23
Other	3	3	8	0	14
Priority Factor 2.5					
TOTAL	15	49	53	11	128
Task No. 47 Dual Slope Integrating ADC					
Research and Development	6	2	8	3	19
Electronic Communications	3	4	8	3	18
Computers	4	5	6	7	22
Manufacturing	8	7	13	3	31
Oil Related	6	10	6	1	23
Other	4	3	6	1	14
Priority Factor 2.6					
TOTAL	31	31	47	18	127
Task No. 48 Charge-Balancing ADC					
Research and Development	2	4	11	2	19
Electronic Communications	2	4	9	2	17
Computers	5	3	8	6	22
Manufacturing	2	7	20	2	31
Oil Related	3	9	9	1	22
Other	2	4	7	1	14
Priority Factor 2.4					
TOTAL	11	39	58	18	126

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UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 49 Quad-Slope Integration					
Research and Development	2	4	11	2	19
Electronic Communications	1	6	8	3	18
Computers	2	6	7	7	22
Manufacturing	3	6	20	2	31
Oil Related	3	11	8	1	23
Other	0	6	4	3	13
Priority Factor 2.4					
TOTAL	11	39	58	18	126

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 50 Descrete Volt. Comparison ADC					
Research and Development	2	5	10	2	19
Electronic Communications	1	5	10	2	18
Computers	1	6	9	4	20
Manufacturing	5	8	16	1	30
Oil Related	4	10	8	0	22
Other	1	3	8	0	12
Priority Factor 2.5					
TOTAL	14	37	61	9	121

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 51 Counter Ramp ADC					
Research and Development	2	5	10	2	19
Electronic Communications	2	6	8	2	18
Computers	4	7	8	3	22
Manufacturing	3	8	18	2	31
Oil Related	6	11	7	0	24
Other	2	3	8	0	13
Priority Factor 2.5					
TOTAL	19	40	59	9	127

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 52 Continuous Ramp ADC					
Research and Development	0	6	10	3	19
Electronic Communications	1	7	7	2	17
Computers	3	7	8	4	22
Manufacturing	2	11	16	3	32
Oil Related	4	11	8	0	23
Other	2	3	8	1	14
Priority Factor 2.4					
TOTAL	12	45	57	13	127

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 53 Successive-Approx. ADC					
Research and Development	4	7	6	3	20
Electronic Communications	3	6	6	3	18
Computers	5	6	6	6	23
Manufacturing	5	11	12	2	30
Oil Related	9	8	6	0	23
Other	3	2	6	2	13
Priority Factor 2.6					
TOTAL	29	40	42	16	127

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 54 Simultaneous (Parallel)ADC					
Research and Development	1	5	10	3	19
Electronic Communications	2	5	8	3	18
Computers	3	5	7	6	21
Manufacturing	3	8	18	2	31
Oil Related	5	6	11	1	23
Other	2	2	8	1	13
Priority Factor 2.4					
TOTAL	16	31	62	16	125

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UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 55 Analog Multiplexers					
Research and Development	3	9	4	2	18
Electronic Communications	4	7	5	0	16
Computers	4	5	9	3	21
Manufacturing	7	13	8	1	29
Oil Related	14	7	2	0	23
Other	5	1	6	0	12
Priority Factor 2.9					
TOTAL	37	42	34	6	119

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 56 Digital Multiplexers					
Research and Development	5	10	2	1	18
Electronic Communications	5	7	4	0	16
Computers	6	8	5	2	21
Manufacturing	8	17	4	0	29
Oil Related	14	6	3	0	23
Other	4	2	6	0	12
Priority Factor 3.1					
TOTAL	42	50	24	3	119

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 57 Non-Encoded Keyboard					
Research and Development	3	7	6	2	18
Electronic Communications	1	9	7	5	22
Computers	3	2	10	4	19
Manufacturing	3	7	19	2	31
Oil Related	3	8	11	0	22
Other	2	3	7	1	13
Priority Factor 2.4					
TOTAL	15	36	60	14	125

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 58 Software Delay					
Research and Development	4	5	8	2	19
Electronic Communications	1	7	7	3	18
Computers	3	4	9	4	20
Manufacturing	3	8	17	2	30
Oil Related	3	6	12	1	22
Other	1	5	7	1	14
Priority Factor 2.4					
TOTAL	15	35	60	13	123

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 59 Rollover					
Research and Development	0	7	9	2	18
Electronic Communications	0	7	6	5	18
Computers	2	3	12	4	21
Manufacturing	1	7	18	3	29
Oil Related	2	7	12	1	22
Other	0	5	7	1	13
Priority Factor 2.2					
TOTAL	5	36	64	16	121

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 60 Two Key Rollover					
Research and Development	0	9	7	3	19
Electronic Communications	0	8	5	6	19
Computers	2	2	12	5	21
Manufacturing	1	7	19	3	30
Oil Related	2	8	12	0	22
Other	0	5	6	2	13
Priority Factor 2.2					
TOTAL	5	39	61	19	124

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UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 61 N-Key Rollover					
Research and Development	0	8	8	3	19
Electronic Communications	0	8	5	6	19
Computers	3	1	11	5	20
Manufacturing	1	6	20	3	30
Oil Related	3	7	12	0	22
Other	0	4	7	2	13
Priority Factor 2.2					
TOTAL	7	34	63	19	123
Task No. 62 N-Key Lockout					
Research and Development	0	8	8	3	19
Electronic Communications	0	7	5	6	18
Computers	3	1	11	5	20
Manufacturing	1	7	19	3	30
Oil Related	3	7	11	1	22
Other	0	4	7	2	13
Priority Factor 2.2					
TOTAL	7	34	61	20	122
Task No. 63 Linereversal Techniques					
Research and Development	0	7	9	3	19
Electronic Communications	1	6	5	6	18
Computers	1	2	9	7	19
Manufacturing	0	6	18	5	29
Oil Related	4	6	10	2	22
Other	0	4	7	2	13
Priority Factor 2.1					
TOTAL	6	31	58	25	120

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 64 Encoded Keyboard					
Research and Development	4	6	7	2	19
Electronic Communications	2	7	5	4	18
Computers	2	7	9	2	20
Manufacturing	3	13	11	2	29
Oil Related	5	5	10	1	21
Other	2	4	7	0	13
Priority Factor 2.6					
TOTAL	18	42	49	11	120
Task No. 65 Keyboard Encoders					
Research and Development	3	6	8	2	19
Electronic Communications	2	7	5	4	18
Computers	1	7	10	3	21
Manufacturing	2	14	14	1	31
Oil Related	6	5	11	0	22
Other	2	5	7	0	14
Priority Factor 2.5					
TOTAL	16	44	55	10	125
Task No. 66 Scanning Chips					
Research and Development	2	6	8	3	19
Electronic Communications	2	6	6	4	18
Computers	1	5	8	6	20
Manufacturing	1	10	17	3	31
Oil Related	5	6	11	0	22
Other	2	4	6	2	14
Priority Factor 2.4					
TOTAL	13	37	56	18	124

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UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 67 ASCII Keyboards					
Research and Development	4	7	6	2	19
Electronic Communications	3	7	4	4	18
Computers	3	6	11	2	22
Manufacturing	4	16	11	1	32
Oil Related	7	10	4	1	22
Other	3	4	3	1	11
Priority Factor 2.7					
TOTAL	24	50	39	11	124

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 68 UARTS					
Research and Development	8	6	3	3	20
Electronic Communications	4	6	4	4	18
Computers	5	3	8	5	21
Manufacturing	7	14	10	1	32
Oil Related	7	10	4	1	22
Other	5	5	3	1	14
Priority Factor 2.8					
TOTAL	36	44	32	15	127

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 69 LED Displays					
Research and Development	5	8	5	0	18
Electronic Communications	3	6	5	1	15
Computers	2	9	6	2	19
Manufacturing	5	17	6	1	29
Oil Related	6	8	7	0	21
Other	2	7	2	0	11
Priority Factor 2.9					
TOTAL	23	55	31	4	113

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 70 Seven Segment					
Research and Development	5	9	4	1	19
Electronic Communications	6	6	5	1	18
Computers	3	7	7	5	22
Manufacturing	5	18	6	2	31
Oil Related	7	6	10	0	23
Other	4	7	3	0	14
Priority Factor 2.8					
TOTAL	30	53	35	9	127

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 71 Multiplexing LEDs					
Research and Development	4	8	5	1	18
Electronic Communications	4	6	7	1	18
Computers	2	8	8	4	22
Manufacturing	1	21	7	2	31
Oil Related	7	5	11	0	23
Other	2	9	3	0	14
Priority Factor 2.7					
TOTAL	20	57	41	8	126

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 72 Matrix LEDs					
Research and Development	1	11	5	2	19
Electronic Communications	4	6	7	1	18
Computers	1	6	10	5	22
Manufacturing	0	15	13	3	31
Oil Related	5	7	11	0	23
Other	2	6	6	0	14
Priority Factor 2.5					
TOTAL	13	51	52	11	127

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UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 73 LCDs					
Research and Development	2	7	2	3	14
Electronic Communications	3	8	5	1	17
Computers	1	4	10	6	21
Manufacturing	3	14	10	3	30
Oil Related	4	7	11	1	23
Other	3	4	5	1	13
Priority Factor 2.5					
TOTAL	16	44	43	15	118
Task No. 74 RS232					
Research and Development	7	7	2	3	19
Electronic Communications	6	5	4	2	17
Computers	6	5	4	5	20
Manufacturing	8	11	8	4	31
Oil Related	7	8	5	2	22
Other	3	9	1	1	14
Priority Factor 2.8					
TOTAL	37	45	24	17	123
Task No. 75 Optical Isolators					
Research and Development	3	10	3	3	19
Electronic Communications	3	7	5	2	17
Computers	3	9	3	5	20
Manufacturing	6	13	7	5	31
Oil Related	6	8	7	2	23
Other	5	3	4	1	13
Priority Factor 2.7					
TOTAL	26	50	29	18	123

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 76 UART Timing					
Research and Development	7	7	2	3	19
Electronic Communications	4	5	6	2	17
Computers	4	7	4	5	20
Manufacturing	6	10	11	4	31
Oil Related	5	8	7	2	22
Other	3	6	3	1	13
Priority Factor 2.7					
TOTAL	29	43	33	17	122
Task No. 77 I/O Subroutines					
Research and Development	3	7	5	4	19
Electronic Communications	3	7	6	2	18
Computers	1	6	7	6	20
Manufacturing	3	12	11	5	31
Oil Related	4	9	7	3	23
Other	4	7	1	1	13
Priority Factor 2.4					
TOTAL	18	48	37	21	124
Task No. 78 Kansas City Standard					
Research and Development	1	2	11	4	18
Electronic Communications	1	3	9	5	18
Computers	0	1	10	9	20
Manufacturing	1	7	16	7	31
Oil Related	2	4	12	2	20
Other	0	3	9	1	13
Priority Factor 2.0					
TOTAL	5	20	67	28	120

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UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 79 IC Controllers					
Research and Development	1	8	5	4	18
Electronic Communications	1	7	5	5	18
Computers	1	2	9	8	20
Manufacturing	1	9	17	4	31
Oil Related	3	7	11	1	22
Other	1	5	6	1	13
Priority Factor 2.3					
TOTAL	8	38	53	23	122
Task No. 80 Timing Problems					
Research and Development	3	10	3	2	18
Electronic Communications	3	9	3	3	18
Computers	4	9	5	2	20
Manufacturing	2	17	11	1	31
Oil Related	3	12	7	0	22
Other	4	6	3	1	14
Priority Factor 2.7					
TOTAL	19	63	32	9	123
Task No. 81 Character Generators					
Research and Development	3	8	6	1	18
Electronic Communications	3	6	7	2	18
Computers	4	8	7	1	20
Manufacturing	3	11	17	0	31
Oil Related	4	9	9	0	22
Other	2	7	5	0	14
Priority Factor 2.7					
TOTAL	19	49	51	4	123

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 82 Raster Generation					
Research and Development	3	8	6	1	18
Electronic Communications	1	8	7	2	18
Computers	3	7	9	1	20
Manufacturing	1	13	17	0	31
Oil Related	2	10	10	0	22
Other	2	7	4	1	14
Priority Factor 2.2					
TOTAL	12	53	53	5	123
Task No. 83 CRT Controllers					
Research and Development	3	8	5	2	18
Electronic Communications	1	10	4	3	18
Computers	2	10	6	2	20
Manufacturing	2	18	10	1	31
Oil Related	2	13	7	0	22
Other	2	8	3	1	14
Priority Factor 2.7					
TOTAL	12	67	35	9	123
Task No. 84 Intelligent CRT					
Research and Development	4	8	4	2	18
Electronic Communications	1	10	4	3	18
Computers	4	8	5	3	20
Manufacturing	3	15	11	2	31
Oil Related	3	10	9	0	22
Other	2	8	2	2	14
Priority Factor 2.7					
TOTAL	18	59	35	12	124

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UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 85 Formating (Basic)					
Research and Development	4	7	4	3	18
Electronic Communications	1	9	5	3	18
Computers	7	6	1	6	20
Manufacturing	4	10	15	2	31
Oil Related	3	10	8	1	22
Other	1	7	4	2	14
Priority Factor 2.6					
TOTAL	20	49	37	17	123

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 86 Hard-Sectoring					
Research and Development	1	8	6	3	18
Electronic Communications	1	7	7	3	18
Computers	1	9	3	6	19
Manufacturing	1	11	17	2	31
Oil Related	2	9	10	1	22
Other	0	4	8	1	13
Priority Factor 2.4					
TOTAL	6	48	51	16	121

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 87 Soft-Sectoring					
Research and Development	1	8	6	3	18
Electronic Communications	1	7	7	3	18
Computers	1	8	5	5	19
Manufacturing	1	11	16	3	31
Oil Related	2	9	10	1	22
Other	0	6	7	1	14
Priority Factor 2.4					
TOTAL	6	49	51	16	122

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 88 Floppy Disk Drives Operat.					
Research and Development	2	10	4	2	18
Electronic Communications	3	6	5	3	17
Computers	8	5	5	2	20
Manufacturing	4	11	15	1	31
Oil Related	3	7	11	1	22
Other	3	5	6	0	14
Priority Factor 2.7					
TOTAL	23	44	46	9	122

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 89 Accessing the Track					
Research and Development	0	11	4	3	18
Electronic Communications	1	8	5	4	18
Computers	5	8	4	3	20
Manufacturing	2	12	15	2	31
Oil Related	1	7	13	1	22
Other	1	6	6	1	14
Priority Factor 2.5					
TOTAL	10	52	47	14	123

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 90 Reading and Writing					
Research and Development	0	11	4	3	18
Electronic Communications	1	9	4	4	18
Computers	5	8	4	3	20
Manufacturing	3	12	14	2	31
Oil Related	1	10	10	1	22
Other	1	6	6	1	14
Priority Factor 2.5					
TOTAL	11	56	42	14	123

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UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 91 Disk Drive Signals					
Research and Development	3	7	7	2	19
Electronic Communications	2	8	5	3	18
Computers	5	6	5	0	16
Manufacturing	3	13	12	1	29
Oil Related	3	8	10	1	22
Other	3	6	4	0	13
Priority Factor 2.7					
TOTAL	19	48	43	7	117

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 92 Motor On					
Research and Development	2	7	7	3	19
Electronic Communications	2	6	6	4	18
Computers	3	10	3	4	20
Manufacturing	2	12	14	3	31
Oil Related	2	7	12	1	22
Other	2	2	9	0	13
Priority Factor 2.4					
TOTAL	13	44	51	15	123

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 93 Direction Select					
Research and Development	2	7	7	3	19
Electronic Communications	2	6	6	4	18
Computers	4	10	3	4	21
Manufacturing	1	13	16	2	32
Oil Related	2	7	12	1	22
Other	2	3	8	1	14
Priority Factor 2.5					
TOTAL	13	46	52	15	126

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 94 Step					
Research and Development	2	7	7	3	19
Electronic Communications	2	6	6	4	18
Computers	4	9	3	4	20
Manufacturing	2	12	16	2	32
Oil Related	2	7	12	1	22
Other	2	3	8	1	14
Priority Factor 2.5					
TOTAL	14	44	52	15	125

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 95 Write Gate					
Research and Development	2	7	7	3	19
Electronic Communications	2	6	6	4	18
Computers	4	8	4	4	20
Manufacturing	1	14	15	2	32
Oil Related	2	7	12	1	22
Other	2	3	8	1	14
Priority Factor 2.4					
TOTAL	13	45	52	15	125

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 96 Track 00					
Research and Development	2	7	7	3	19
Electronic Communications	2	6	6	4	18
Computers	5	9	2	4	20
Manufacturing	2	12	16	2	32
Oil Related	2	7	12	1	22
Other	2	3	8	1	14
Priority Factor 2.5					
TOTAL	15	44	51	15	125

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UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 97 Index/Sector					
Research and Development	2	7	7	3	19
Electronic Communications	2	6	6	4	18
Computers	5	8	3	4	20
Manufacturing	3	11	16	2	32
Oil Related	2	7	12	1	22
Other	2	3	8	1	14
Priority Factor 2.5					
TOTAL	16	42	52	15	125
Task No. 98 Status Signals					
Research and Development	1	9	6	3	19
Electronic Communications	2	6	5	4	17
Computers	4	6	5	4	19
Manufacturing	2	14	14	2	22
Oil Related	3	9	10	1	23
Other	2	4	6	1	13
Priority Factor 2.5					
TOTAL	14	48	46	15	123
Task No. 99 Ready I					
Research and Development	1	8	6	3	18
Electronic Communications	1	8	5	4	18
Computers	4	6	6	4	20
Manufacturing	1	14	14	2	31
Oil Related	1	8	12	1	22
Other	1	4	7	1	13
Priority Factor 2.4					
TOTAL	9	48	50	15	122

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 100 Index					
Research and Development	1	9	6	3	19
Electronic Communications	1	7	6	4	18
Computers	4	7	5	4	20
Manufacturing	1	12	16	2	31
Oil Related	1	8	12	1	22
Other	1	4	7	1	13
Priority Factor 2.4					
TOTAL	9	47	52	15	123
Task No. 101 Write-Protect					
Research and Development	1	9	6	3	19
Electronic Communications	1	7	6	4	18
Computers	4	7	5	4	20
Manufacturing	1	12	19	2	34
Oil Related	2	8	11	1	22
Other	2	3	7	1	13
Priority Factor 2.4					
TOTAL	11	46	54	15	126
Task No. 102 Cyclic Redundancy Check					
Research and Development	1	9	5	3	18
Electronic Communications	2	5	6	4	17
Computers	4	7	5	5	21
Manufacturing	3	11	15	2	31
Oil Related	3	9	7	1	20
Other	0	4	7	1	12
Priority Factor 2.5					
TOTAL	13	45	45	16	119

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UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 103 Controller Chips					
Research and Development	0	12	5	2	19
Electronic Communications	0	9	6	3	18
Computers	3	5	6	5	19
Manufacturing	3	13	13	2	31
Oil Related	2	13	5	1	21
Other	1	5	5	1	12
Priority Factor 2.5					
TOTAL	9	57	40	14	120
Task No. 104 Burst Mode					
Research and Development	1	8	9	1	19
Electronic Communications	1	5	10	2	18
Computers	2	7	6	3	20
Manufacturing	2	12	15	2	31
Oil Related	1	9	11	1	22
Other	1	4	8	0	13
Priority Factor 2.4					
TOTAL	8	45	61	9	123
Task No. 105 Distributed or Single Cycle Mode					
Research and Development	1	8	9	1	19
Electronic Communications	1	5	10	2	18
Computers	2	9	7	3	21
Manufacturing	2	11	16	2	31
Oil Related	2	8	12	1	23
Other	1	4	8	0	13
Priority Factor 2.4					
TOTAL	9	45	62	9	125

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 106 Refresh Controller Chips					
Research and Development	2	10	5	2	19
Electronic Communication	0	6	8	3	17
Computers	3	8	5	5	21
Manufacturing	2	13	13	3	31
Oil Related	2	11	8	2	23
Other	1	6	5	1	13
Priority Factor 2.5					
TOTAL	10	54	44	16	124
Task No. 107 Asynchronous Access					
Research and Development	1	9	7	2	19
Electronic Communications	1	6	8	3	18
Computers	2	7	6	5	20
Manufacturing	2	11	15	3	31
Oil Related	1	10	10	1	22
Other	1	5	6	1	13
Priority Factor 2.4					
TOTAL	8	48	52	15	123
Task No. 108 Hidden Refresh					
Research and Development	3	8	7	1	19
Electronic Communications	4	5	5	4	18
Computers	1	7	7	5	20
Manufacturing	3	9	17	2	31
Oil Related	2	11	8	1	22
Other	1	4	8	0	13
Priority Factor 2.5					
TOTAL	14	44	52	13	123

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UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 109 S-100					
Research and Development	1	6	8	5	20
Electronic Communications	2	5	5	6	18
Computers	0	6	8	5	19
Manufacturing	1	11	15	4	31
Oil Related	3	8	10	1	22
Other	0	4	7	2	13
Priority Factor 2.3					
TOTAL	7	40	53	23	123
Task No. 110 IEEE-488					
Research and Development	6	8	2	4	20
Electronic Communications	3	8	4	3	18
Computers	3	4	6	6	19
Manufacturing	8	4	15	2	31
Oil Related	3	10	7	1	21
Other	2	5	4	2	13
Priority Factor 2.6					
TOTAL	25	41	38	18	122
Task No. 111 IEEE-583 CAMAC					
Research and Development	1	4	11	4	20
Electronic Communications	1	5	9	3	18
Computers	0	3	8	7	18
Manufacturing	1	9	19	2	31
Oil Related	0	7	11	3	21
Other	0	3	8	2	13
Priority Factor 2.1					
TOTAL	3	31	66	21	121

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 112 EIA-RS232C					
Research and Development	7	7	5	1	20
Electronic Communications	5	8	2	3	18
Computers	8	5	3	4	20
Manufacturing	10	11	8	2	31
Oil Related	7	11	3	1	22
Other	4	5	2	2	13
Priority Factor 2.9					
TOTAL	41	47	23	13	124
Task No. 113 EIA-RS422, RS423					
Research and Development	3	7	7	3	20
Electronic Communications	4	5	5	4	18
Computers	3	3	7	6	19
Manufacturing	0	11	18	3	32
Oil Related	3	8	7	3	21
Other	0	4	7	2	13
Priority Factor 2.3					
TOTAL	13	38	51	21	123
Task No. 114 ASCII Information					
Research and Development	7	3	7	3	20
Electronic Communications	5	5	5	4	18
Computers	3	6	5	6	20
Manufacturing	7	14	8	3	32
Oil Related	8	8	5	0	21
Other	4	3	4	2	13
Priority Factor 2.7					
TOTAL	34	39	34	17	124

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UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 115 UART-Programmable Communication Interface					
Research and Development	9	7	2	2	20
Electronic Communications	5	7	3	3	18
Computers	9	4	4	3	20
Manufacturing	8	15	6	2	31
Oil Related	12	5	4	1	22
Other	6	2	4	1	13
Priority Factor 3.0					
TOTAL	49	40	23	12	124

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 116 PIO-Programmable I/O Port					
Research and Development	9	5	3	3	20
Electronic Communications	3	7	5	3	18
Computers	7	3	4	4	18
Manufacturing	6	12	8	3	29
Oil Related	5	13	3	1	22
Other	4	4	3	2	13
Priority Factor 2.8					
TOTAL	34	44	26	16	120

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 117 DMAC-Direct Memory Access Controller					
Research and Development	8	5	4	3	20
Electronic Communications	6	5	4	3	18
Computers	7	4	5	4	20
Manufacturing	6	16	6	3	31
Oil Related	10	6	5	1	22
Other	4	3	4	2	13
Priority Factor 2.8					
TOTAL	41	39	28	16	124

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 118 PIC-Programmable Interrupt Controller					
Research and Development	8	5	4	3	20
Electronic Communications	4	6	5	3	18
Computers	5	6	5	4	20
Manufacturing	4	17	7	3	31
Oil Related	5	13	3	1	22
Other	4	2	5	2	13
Priority Factor 2.8					
TOTAL	30	49	29	16	124

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 119 PIT-Programmable Interval Timer					
Research and Development	7	7	3	3	20
Electronic Communications	4	5	6	3	18
Computers	4	7	5	4	20
Manufacturing	4	16	8	3	31
Oil Related	4	10	7	1	22
Other	4	1	6	2	13
Priority Factor 2.7					
TOTAL	27	46	35	16	124

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 120 PIA-Peripheral Interface Adapter					
Research and Development	9	6	2	3	20
Electronic Communications	4	8	3	3	18
Computers	7	4	5	4	20
Manufacturing	6	15	7	3	31
Oil Related	7	11	5	0	23
Other	4	2	5	2	13
Priority Factor 2.8					
TOTAL	37	46	27	15	125

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UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. 121 Printer-Serial-Line					
Research and Development	1	0	0	0	1
Electronic Communications	0	4	0	3	7
Computers	1	0	0	0	1
Manufacturing	3	0	0	0	3
Oil Related	5	0	0	0	5
Other	0	0	0	0	0
Priority Factor 3.2					
TOTAL	10	4	0	3	17

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. ______					
Research and Development					
Electronic Communications					
Computers					
Manufacturing					
Oil Related					
Other					
Priority Factor ______					
TOTAL					

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. ______					
Research and Development					
Electronic Communications					
Computers					
Manufacturing					
Oil Related					
Other					
Priority Factor ______					
TOTAL					

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. ______					
Research and Development					
Electronic Communications					
Computers					
Manufacturing					
Oil Related					
Other					
Priority Factor ______					
TOTAL					

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. ______					
Research and Development					
Electronic Communications					
Computers					
Manufacturing					
Oil Related					
Other					
Priority Factor ______					
TOTAL					

UNIT HEADING	TAUGHT IN DEPTH	EMPHASIZED	DISCUSSED BRIEFLY	NOT TAUGHT	TOTAL
Task No. ______					
Research and Development					
Electronic Communications					
Computers					
Manufacturing					
Oil Related					
Other					
Priority Factor ______					
TOTAL					