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ABSTRACT

A project designed a national curriculum model for Energy Conservation-and-Use Technicians (ECUTs) and developed and tested instructional materials for use in the courses. The two-year postsecondary ECUT curriculum was designed to provide an interdisciplinary technical base (electrical, mechanical, thermal, and fluidal principles) and technical specialty training. Sixteen courses, consisting of 124 course modules, were developed specifically for ECUT training: Fundamentals of Energy Technology; Energy Economics; Energy Production Systems; Energy Conservation; Energy Audits; Heating, Ventilation, and Air Conditioning; Microcomputer Operations; Microcomputer Hardware; Electronic Devices and Systems; Electrical Power and Illumination Systems; Technical Communications; Mechanical Devices; Instrumentation and Controls; Fluid Power Systems; and Chemistry for Energy Technology I and II. Each module contains an introduction, prerequisites, objectives, subject matter, exercises, laboratory materials and procedures, data tables, reference materials, and test. Four schools piloted the curriculum and provided feedback for materials improvement. The materials were used by postsecondary institutions for two-year ECUT programs, for selected courses infused into other technical specialties, for adult and community education courses, and for employer-sponsored retraining courses. (Appendixes, amounting to over one-half of the report, include a list of equipment used by ECUTs, curriculum design, information booklet, and diffusion workshop materials.) (YLB)

Final Report

Project No. 498AH80027
Contract No. 300780551

CURRICULUM FOR ENERGY USE AND CONSERVATION TECHNICIANS

Daniel M. Hull
Technical Education Research Center - Southwest
Waco, Texas
Center for Occupational Research and Development

November 1981

The work reported herein was performed pursuant to a contract with the Office of Vocational and Adult Education, United States Department of Education. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judgment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official Department of Education position or policy.

UNITED STATES DEPARTMENT OF EDUCATION

Office of Vocational and Adult Education
Division of National Vocational Programs

ABSTRACT

Energy is a technically broad, interdisciplinary field. It is also a field that is changing rapidly. The postsecondary curriculum for Energy Conservation-and-Use Technicians (ECUTS) was designed to provide a broad technical base and allow the graduate technicians maximum flexibility and lateral mobility in the work environment.

Energy Conservation-and-Use Technology embraces four major areas of work:

Energy Research and Development.
Energy Production.
Energy Use.
Energy Conservation.

The ECUT project included needs assessment, job analysis, curriculum design, instructional materials development, field tests, and materials/programs dissemination. More than five thousand pages of instructional materials (120 modules) were developed, tested, and revised. Four schools piloted the entire two-year curriculum and provided feedback for materials improvement. The instructional materials have been used by postsecondary institutions for two-year ECUT programs, for selected courses infused into other technical specialties, for adult and community courses, and for employer-sponsored retraining courses.

PREFACE

The design, operation, and maintenance of modern production and building equipment requires a new generation of systems-oriented technicians. Men and women who are prepared to enter this sector of today's workforce must be interdisciplinary, possessing combinations of skills in two or more areas of electrical, mechanical, thermal, fluidal, and optical technologies.

This subtle need has been brought into national prominence by the dilemma of the educational community to respond to the requirement for engineering technicains to work in energy-related fields. The technology(s) associated with energy production, use, and conservation, is representative of the technical complexity of modern equipment. This report describes a three-year project to develop, test, and disseminate a postsecondary curriculum for Energy Conservation-and-Use Technicians (ECUT).

The project was guided by a cooperative and responsive advisory committee whose membership is listed in Appendix A. But, the project is particularly indebted to the four institutions and their coordinators who pilot-tested and critiqued the entire ECUT curriculum:

Pat Enz - Red Wing Energy Education Center, Minnesota
Arlen Hackbarth - Marshalltown Community College, Iowa
Wade Harper - Horry-Georgetown Technical College, South Carolina
Ivonna McCabe - Tacoma Community College, Washington

Last of all, I want to express my sincere appreciation to a warm friend and respected colleague, Dr. Walter J. Brooking, who provided invaluable suggestions and encouragement.

Daniel M. Hull
Project Director

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INTRODUCTION

BACKGROUND

In the recent decade of the 1970s, alarming shortages and escalating costs of energy emerged as a problem of national concern. Consumers asked "How can I keep utility bills down?" Business and industry speculated on the availability and cost of future energy resources. Research establishments laid plans to develop alternatives to petroleum as a fuel. Electric power plants began converting buildings and equipment to take advantage of other fuels.

In this setting, energy technology has evolved to what it is today — a very broad, technical discipline encompassing the production, conservation and utilization of energy, and research and development related to these areas. With the evolution of energy technology there has evolved also a need for technicians with employable skills and knowledge in the energy-related technologies. In this report, these technicians will be designated Energy Conservation-and-Use Technicians, or ECUTs.

Definition of Energy Conservation-And-Use Technician

Prior to considering an Energy Conservation-and-Use Technician curriculum, it is necessary to define the technician. The first step in this definition is to identify fields in which such a technician might be employed, e.g.:

- Energy-related research and development.
- Energy production (electric power plants, solar collectors, etc.).
- Energy use (factories, buildings, equipment, etc.).
- Energy conservation (audits, construction techniques, retrofits, etc.).

Similarly, functions performed by such a technician should be identified, e.g.:

- Provide direct support to engineers/scientists.
- Operate and/or maintain mechanical, electrical/electronic, electro-mechanical or more complex equipment or systems.

- Perform building "operating engineer services" (operation and maintenance of building HVAC, electrical, and mechanical systems).
- Perform systems operational tests and analyses.
- Perform energy-use audits.
- Perform energy conservation technical services: construction, retrofits, load balancing, etc.
- Install and monitor equipment.

In addition to the technical specialists who are currently practicing in our country's workforce, a growing need exists for systems-oriented technicians who are capable of understanding the diversity of components that exist in modern equipment and the interrelationship between these components. The energy technician can apply this knowledge in a variety of tasks to develop, construct, test, install, operate, and maintain today's modern equipment in the energy and energy-related technologies.

Equipment associated specifically with those technologies dedicated to the production, utilization, and conservation of energy is typical of today's modern, complex equipment. Such equipment may contain electric motors, heaters, lamps, electronic controls, mechanical drives and linkages, thermal systems for cooling and drying, lubricants, optical or microwave systems and conjunction links, pneumatic and hydraulic drives, pneumatic controls and, in some instances, even nuclear radioactive samples and counters. If energy technicians are to work effectively with modern equipment of this type, they must have an understanding of the underlying technical disciplines - mechanical, electrical, thermal, hydraulic, and optical - and their interrelationships.

Based on the criteria noted above, a very general definition of an Energy Conservation-and-Use Technician can be formulated:

> A systems-oriented worker who possesses a combination of skills and abilities and can apply this interdisciplinary capability in jobs to develop, construct, test, operate, maintain, and/or install modern equipment used in homes, businesses, institutions, factories, and other installations. Typically, this equipment consists of systems utilizing combinations of mechanical, electrical, thermal, fluid, and/or optical components, and frequently these systems are controlled by electronic computers or microprocessors.

Job Descriptions

Because the ECUT can work for such a wide variety of employers, the job definition in the previous section is very general and not particularly useful. A degree of specificity can be made, however, if job descriptions are presented according to each of the four major areas of energy use and conservation.

A. Energy-Related Research and Development

1. Employers: Research and development organizations within institutions, private industry, government, and the military.

2. Job Description: Under the direction of an engineer, physicist, chemist, or metallurgist, the technician will design, construct, and operate breadboards or laboratory experiments involving complex physical phenomena and equipment, perform tests and measurement on system performance, document results in reports and/or laboratory notebooks, and perform periodic maintenance and repair of equipment. Test data frequently will be acquired and reduced via interfaces with laboratory microcomputers. The technician will frequently supervise other workers.

B. Energy Production

1. Employers: Power plants, solar energy equipment manufacturers, installers and users; process plants that use high-temperature heat, steam or hot water.

2. Job Description: Develops, installs, operates, maintains, modifies, and repairs systems and devices used for the conversion of fuels and other resources into useful energy. Systems may be furnaces or plants to produce hot water, steam, mechanical motion, or electrical power. Typical systems, which include furnaces, electrical power plants, and solar heating systems, may be controlled manually, by semiautomated control panels, or computers. The technician will frequently supervise other workers.

C. Energy Use

1. Employers: Production line equipment maintenance; building and/or plant equipment maintenance; maintenance departments of hospitals,

apartments, hotels/motels, office buildings, schools, churches, shopping centers, and restaurants.

2. Job Description: Installs, operates, maintains, repairs, and modifies complex electromechanical, thermal, fluid, and optical systems used in production lines and for climate control and hot-water supply in hospitals, apartments, hotels/motels, office buildings, schools, churches, shopping centers, and restaurants. This type of equipment may be automatically controlled with micro-computers. The technician will frequently supervise other workers.

D. Energy Conservation

1. Employers: Consulting engineers, energy audit firms, residential and commercial energy audit departments of public utility companies, municipal governments, architects, builders, and HVAC equipment manufacturers' representatives and sales outlets.

2. Job Description: The ECUT typically would work on a team led by an engineer, performing the following activities: determine specifications for new-building construction, modifications, and retrofits (equipment, structures, and installation); use instruments and procedures, and perform calculations, to measure energy use and efficiency of components and systems (which may provide support to the building or activities within it); perform audits of energy use and management, including economic cost-versus-benefits analyses; through written documents or oral presentations, recommend building retrofits and/or changes in equipment to achieve energy savings. The technician will frequently supervise other workers.

Some of the jobs for Energy Conservation-and-Use Technicians may be identified with employers under the following job titles:

- Technician
- System Technician
- Plant Operator
- Electromechanical Technician
- Building Maintenance Technician
- Energy Conservation Technician
- Energy Management Technician
- Production Equipment Technician

- Instrumentation and Control Technician
- Control Room Operator
- Operating Engineer
- Building Operation Equipment Technician
- Energy Audit Technician
- Laboratory Technician

PROJECT DESCRIPTION

On October 1, 1978, the Technical Education Research Center - Southwest began a three-year project to design a national curriculum model for Energy Conservation-and-Use Technicians, develop and test instructional materials for use in the courses, and conduct a limited dissemination of the program and materials. Specifically, the project included the following major activities:

A. Determine the current and projected needs for ECUTs.

B. Identify existing training programs for Energy Conservation-and-Use Technicians and the availability of appropriate instructional materials.

C. Design a curriculum (sequence of courses) and identify the content for instructional materials needed to train ECUTs.

D. Develop performance-based, modular instructional materials for courses to train ECUTs.

E. Plan and conduct a field test of the ECUT curriculum in six postsecondary institutions.

F. Plan and conduct a familiarization program of the ECUT project and its curriculum materials.

G. Prepare a program planning guide for postsecondary institutions to train Energy Conservation-and-Use Technicians.

H. Plan and conduct regional diffusion workshops to disseminate information and materials for the Energy Conservation-and-Use Technician programs.

Three modifications were made to the original project Statement of Work:

1. The original purpose of the field tests (Task E above) was threefold:
    - To obtain information from instructors and students on how to improve the content and format of the course materials.

- To provide exemplary programs to be used as models for other institutions during the dissemination activities.
- To obtain evaluation data on student achievement (i.e., pre- and post-test data). This data was to be presented to the Joint Dissemination Review Panel for approval.

The last objective was dropped because there was insufficient time in the first year of the project to obtain approval from the Office of Management and Budget (OMB) to collect student data (profiles, test results, and so forth) for a summative field test.

2. The number of diffusion workshops was increased from four to five (a workshop was held in Hawaii for this state and the Pacific Territories) in order to reduce the total travel costs for the participants.
3. The duration of the project was extended from the original completion date of September 30, 1981, to November 30, 1981, to present more complete data on program interest and materials usage.

PROJECT ACTIVITIES AND RESULTS

The ECUT project was initiated on October 1, 1978, and scheduled to be completed in three years. To be able to field test the complete, two year curriculum and instructional materials and to utilize the field-test results within the duration of the contract, it was necessary for the field-test sites (six schools) to recruit students and begin classes in late August of 1979 - less than eleven months after the project began. During this first eleven-month period the following tasks required completion:

- Organize and assemble advisory committee.
- Determine workforce needs for ECUTs.
- Identify the content for an ECUT curriculum.
- Assess the appropriateness of available instructional materials for the ECUT courses.
- Design, develop, obtain critiques, and revise instructional modules for courses in the first year of the ECUT curriculum.
- Enlist six schools to field test the ECUT program beginning in August or September 1979.
- Provide assistance to the field-test schools in obtaining state approval to offer the program, designing labs, selecting equipment, and locating instructors.
- Conduct teacher workshops for the field-test schools.
- Provide to the teachers and students at the field-test sites sufficient copies of first year materials.

In order to meet all deadlines during the first year of the project, certain assumptions were made about the characteristics of the ECUT and the types of courses required in the curriculum. These assumptions were that the ECUT required a technially broad-based interdisciplinary training program, and that the curriculum would consist mainly of a "technical core" of courses, with only five or six "technical specialty" courses related specifically to energy conservation. These assumptions (which were stated in the project proposal and in the introduction to the final report) were approved by the advisory committee and later substantiated in the needs assessment and the task work leading to the curriculum design.

The remainder of this section of the final report describes the major tasks of the project, the methods used to accomplish these tasks, and the results achieved.

USE OF PROJECT ADVISORY COMMITTEE

As the first step toward the completion of this project, TERC-SW recruited twenty-three persons to constitute the Project Advisory Committee. Members of this committee, from the fields of education, industry, and government, are listed in Appendix A. The Committee assisted TERC-SW in the conduct of the project by participating in the following ways:

- Described job categories for energy technicians.
- Identified potential employer categories for obtaining needs-assessment data.
- Reviewed task inventory data and curriculum design.
- Reviewed and suggested changes in course content for technical specialty courses.
- Reviewed and suggested changes for selected instructional module drafts.
- Reviewed and suggested changes for the Curriculum Planning Guide.

NEEDS ASSESSMENT

To justify the subsequent curriculum development work, a national assessment was made of employer needs for ECUTs, both currently (in 1978-79) and on a projected basis, through 1988. Because of requirements for OMB approval (which would have delayed the assessment and made the completion of the first year tasks impossible) TERC-SW could not conduct as a part of this project an independent survey of employer needs. However, a determination was made of future jobs for ECUTs by analyzing related surveys that were conducted during this same time frame.

Dr. Kris K. Moore of the Hankamer School of Business at Baylor University conducted a national survey of employers to determine relative needs within the workforce for employers engaged in "planning energy use and/or applying energy conservation methods" in specified areas such as heating, cooling, and lighting. Nine hundred eighty-six employers throughout the nation were surveyed as to needs for technicians in energy-related fields. These employers can be grouped into the following nine categories: 1) research and development organizations, 2) utility companies, 3) manufacturing plants, 4) processing plants, 5) hotels/motels/apartments, 6) office and business building managers, 7) schools/hospitals, 8) architectural and construction firms, and 9) consulting engineers. The results of Moore's survey showed the average annual need for new "energy technicians" for the decade to be 7,352, with the total need for the same ten-year period being 73,520. Additionally, seven, two-year, postsecondary schools, interested in becoming field-test sites for the ECUT Program, conducted independent surveys within their service regions. These seven surveys, which described the energy technician according to the broad technical base required queried 2,412 employers. The surveys compared favorably with Moore's work, and verified the need for training programs to provide preemployment training for Energy Conservation-and-Use Technicians.

An analysis of these surveys as well as eight other workforce studies conducted during this time period is documented in the report for Subpart 1, Task A, Phase 1, Project No. 498AH80027, entitled, "An Assessment of Employer Needs for Energy Use and Conservation Technicians." Copies can be obtained by requesting TERC-SW Report No. 413-02A, January 5, 1979.

STATUS OF EXISTING PROGRAMS AND INSTRUCTIONAL MATERIALS

The purposes of this task were to assess the status of postsecondary training programs for Energy Conservation-and-Use Technicians (or alternate job titles) and to determine the availability of suitable curriculum materials appropriate to these training programs.

To complete the curriculum state-of-the-art assessment, TERC-SW staff conducted extensive library and telephone research. Employers with training programs were also visited to determine what materials were in use. Telephone inquiries were made to schools, and the Project Advisory Committee members were asked to assist in identifying existing curriculum materials.

At the time of the telephone inquiries to determine available materials, TERC-SW requested information on any existing programs for the training of energy conservation-and-use technicians. This effort was aided significantly by information obtained from the Vocational/Technical Education section of the Education Programs Division, United States Department of Energy. In the fall of 1979, the offices of the state directors of vocational and/or community colleges supplied the DOE a comprehensive listing and descriptions of postsecondary energy-related programs in two-year vocational/technical schools and community colleges. Raw data submitted from 38 states was made available to the TERC-SW staff for reduction and analysis.

The programs status assessment revealed approximately 400 schools and training entities offering specialized energy-intensive training (e.g., solar mechanics, energy audits, insulation installation, etc.) but not a single comprehensive curriculum as a program designed to produce the interdisciplinary technician for the energy-related industrial community. Corresponding results were obtained in the assessment of materials suitable for use in the Energy Conservation-and-Use Technician Curriculum - i.e., appropriate materials were not available.

The results of this study were documents in Subtasks 2 and 3, Task A, Phase 1, Project No. 498AH80027 Report entitled, "An Assessment of State-of-the-Art Curriculum Materials," and "A Status Assessment of Training Programs for Energy Conservation and Use Technicians." Copies can be obtained by requesting TERC-SW Report No. 413-02B, January 5, 1979.

CURRICULUM DESIGN

Because of the breadth of jobs available to ECUTs, a single list of tasks and required knowledge for successful job performance is almost limitless, and impossible to describe succinctly. However, to assist in designing the model curricula, an inquiry on job tasks was made to selected employers serving on the National Advisory Committee. Nine members provided sufficient information to form a collective profile of tasks:

Sandia Corporation (Energy R & D)
Dallas Power and Light Company (Energy Conservation)
Holiday Inns of America (Energy Use)
Cities Service Corporation (Energy Production)
Los Alamos National Laboratory (Energy R & D)
Scott and White Memorial Hospital (Energy Use)

Trammel Crow Office Building Management (Energy Use)
Vought Corporation (Energy Conservation)
ASHRAE Education Committee Representative

The useful data obtained from the inquiry pertained to the types of equipment with which ECUTs would work and the nature (or scope) of work they would perform.

Equipment

The graph shown in Figure 1 represents the equipment or subject areas that were considered important by employers of energy technicians. A listing of important equipment within each category is shown in Appendix B. The percentages assigned to each category in the graph represent the average of the items of equipment identified by each employer compared to the total number of equipment items in that category. The nearly uniform distribution through the nine categories indicates the breadth of technical competencies required for ECUTs.

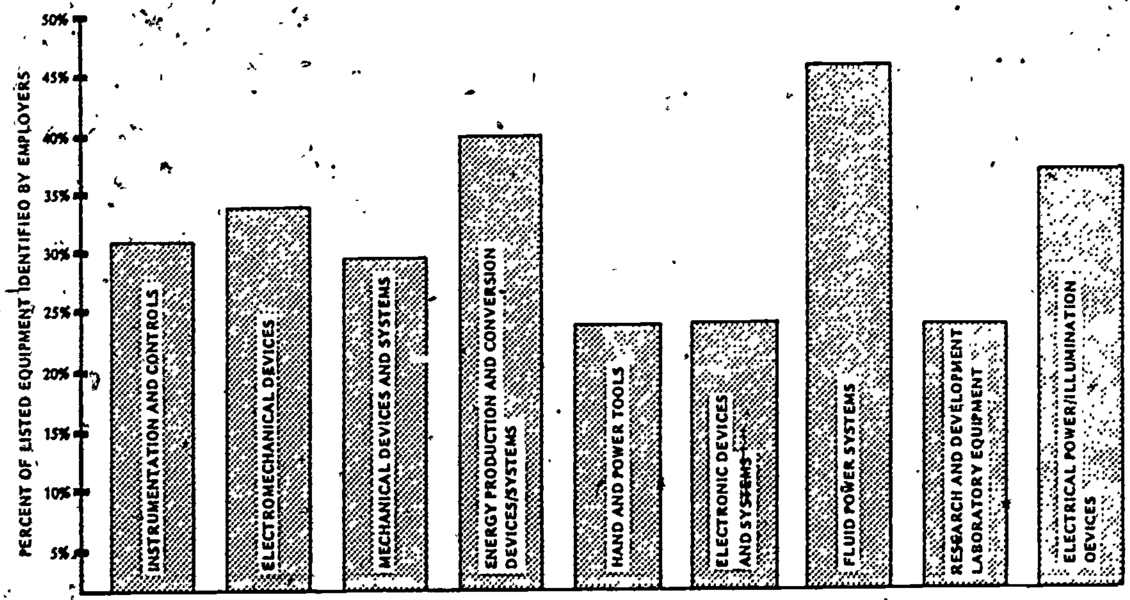

Figure 1. ECUTs work with equipment in these technical categories.

Tasks

Employers were asked how frequently ECUTS work with the equipment listed in Appendix B. They weighted their responses accordingly: never - 0 points; infrequently (once per month or less) - 1 point; occasionally (once per week) - 2 points; frequently (daily) - 3 points. The graph shown in Figure 2 illustrates the specific tasks or job skills that ECUTS are required to perform on various types of equipment.

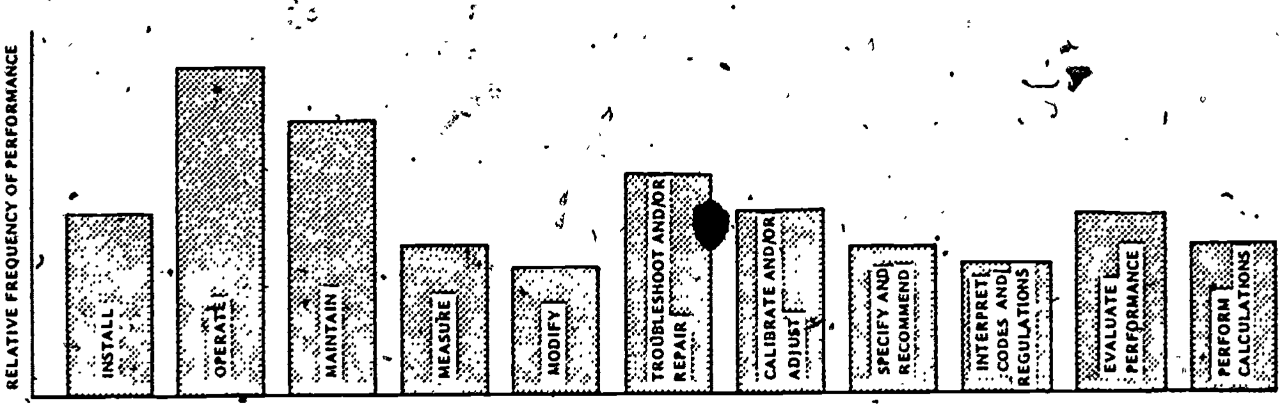

Figure 2. What types of tasks do ECUTs perform?

Communication Skills

Not included in either of these two graphs are the communications job skills emphasized by employers, such as:

Verbal - The ECUT must be able to communicate not only with other technical persons, but also with nontechnical persons such as business persons, operators, and maintenance mechanics, and the general public.

Written - ECUTs must be able to write letters, specifications, and reports, and maintain laboratory notebooks. They must also be able to make simple equipment and fabrication sketches and schematics, and be able to read and interpret complex schematics, blueprints, and instruction manuals.

Courses

The ECUT curriculum design (course sequence shown in Appendix C) represents a major innovation in technician curriculum design for the 1980s. It reflects the need for technicians to have an interdisciplinary technical base (electrical, mechanical, thermal, and fluidal principles) and the recent desire and willingness by employers to provide additional specialization or retraining for their employees as the need arises.

This technically broad-based curriculum contains four types of courses, which can be grouped accordingly:

Support courses
Principles courses
Devices courses
Systems courses

These groupings are shown graphically in Figure 3.

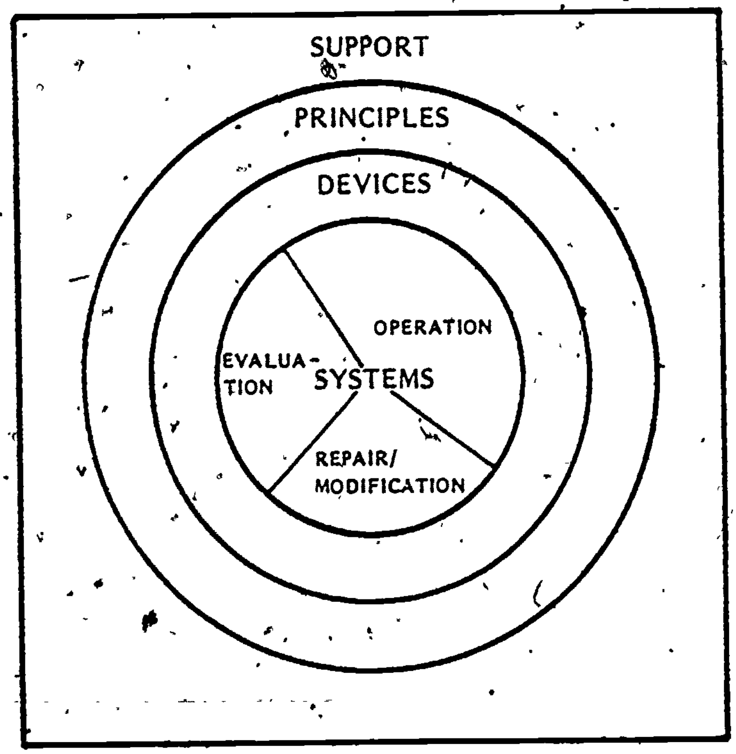

Figure 3. ECUT course groupings.

This type of curriculum implementation offers many flexibilities to schools in program implementation and in utilization of instructors and laboratories, which may result in opportunities for savings in operating costs.

Unified Technical Concepts (UTC)

Also noted in Figure 4 is the large percentage (18%) of the curriculum devoted to Unified Technical Concepts (Physics).

Technical education has for many years been characterized by a process of teaching technical principles by practical applications. To retain this extremely effective process while, at the same time, introducing a broader range of technology, the ECUT curriculum adopted the Unified Technical Concepts method of physics instruction. In this sytem basic concepts are selected that have applications in several fields of technology. Instead of a vertical structure in which the traditional fields of physics (electricity, heat mechanics, fluids, etc.) are studied as separate phenomena, the unified concepts system selects single concepts that cut squarely across these traditional groupings. With this system it is possible to utilize practical industrial applications to teach principles such as: force, rate, resistance to flow, time constants, energy converters, force transformers, etc. Interesting applications from modern commercial equipment provide the laboratory experiences for the unified concepts, instead of the technical "apparatus" of the traditional physics laboratory.

Mathematics

Mathematics, long a stumbling block for many students, is given valuable reinforcement when the same mathematical formula is repeated many times in problems dealing with mechanical, electrical, pneumatic, and thermal examples of a single concept. A set of eight mathematics modules have been

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- Formula Interpretation
- International System of Units
- Logarithms and Exponents
- Angles and Triangles
- Vectors and Scalars
- Dimensional Analysis
- Reading and Drawing Graphs
- Precision, Accuracy, and Measurement

A more complete description of UTC, the 183 instructional modules for technical physics, and implementation techniques is contained in the UTC Instructor's Guide.*

Courses Developed

From the state-of-the-art research (described in the previous section) it was evident that some courses were available as a part of the offerings of most schools. Sixteen courses (listed below), consisting of 124 course modules, were selected to be developed for the training of ECUT technicians.

- Fundamentals of Energy Technology
- Energy Economics
- Energy Production Systems
- Energy Conservation
- Energy Audits
- Heating, Ventilation, and Air Conditioning
- Microcomputer Operations
- Microcomputer Hardware
- Electronic Devices and Systems
- Electrical Power and Illumination Systems
- Technical Communications
- Mechanical Devices
- Instrumentation and Controls
- Fluid Power Systems
- Chemistry for Energy Technology - I & II

The descriptions and module listings for these courses are also included in Appendix C.

*This document can be obtained from the Center for Occupational Research and Development, 601 Lake Air Drive, Suite C, Waco, Texas 76710.

Module outlines and objectives were prepared for all the courses in the ECUT curriculum and compiled into the 446-page ECUT Curriculum Development Guide, Document No. 78-63-02C. The content of each course in the guide was reviewed by the Project Advisory Committee and representatives of the field-test schools. Changes were recommended and revisions were incorporated.

A decision was made to not develop materials for the course entitled "Codes and Regulations" because the national Electrical Codes are already published, and other building codes and restrictions related to energy equipment and facility design and installation vary from state to state.

INSTRUCTIONAL MATERIALS DEVELOPMENT

Authors were selected from experts in industry and schools to write the instructional modules for the ECUT courses listed in the previous section. Each author was provided the module outline and objectives contained in the Curriculum Development Guide. Module drafts received from the authors were reviewed by the project staff to determine if they conformed to the outlines and adequately covered the objectives. The staff then performed grammatical and format edits, and the module drafts were typed and illustrated.

Nine copies of each module were submitted to selected reviewers, who commented on the technical accuracy and relevance of the material content. Revisions were made to the modules based on the reviewers' comments. Many of the candidates for module authors and reviewers were suggested by the Project Advisory Committee.

Each instructional module developed specifically for the ECUT curriculum contains these basic elements:

Introduction: Identifies topic (and often includes rationale for studying the material).

Module Prerequisites: Identifies knowledge and skills students should possess before studying the module.

Objectives: Clearly identifies what the student is expected to know and do upon completion of the module. Objectives are stated in terms of action-oriented behaviors, including such terms as "operate," "measure," "calculate," "identify," and "define," instead of words with many interpretations such as "know," "understand," "learn," and "appreciate."

Subject Matter: Presents background, theory, and techniques supporting the objectives. (Subject Matter is written with the technical student in mind.)

Exercises: Provides practical problems to which students can apply new knowledge from module study.

Laboratory Materials: Identifies equipment required to complete laboratory procedures.

Laboratory Procedures: Presents experiments or "hands-on" activities, including step-by-step instructions. (Experiments are designed to reinforce student learning.)

Data Tables: Included in most first-year or basic-course modules, the data tables help students learn how to collect and organize data.

Reference Materials: Presents suggestions for supplementary readings.

Test: Measures each student's achievement against objectives stated at the beginning of the module.

Modules average approximately 35 typewritten pages, including illustrations. (Illustrations normally are line drawings that are easily understood and can be reproduced on copy machines for overhead projection.) New modules can be added easily, or existing ones modified, for self-paced instruction or short courses. Materials were written for a prerequisite math competency not to exceed trigonometry and reading level ranging from 9th to 11th grade equivalency.

FIELD TESTS

As mentioned in the Introduction, the purpose of the field tests in this project was modified to provide information primarily from students and teachers about how the materials could be improved.

Six schools were to be selected as field-test sites. Candidate sites were:

Albuquerque Technical Vocational Institute, Albuquerque, New Mexico
Asnuntuck Community College, Enfield, Connecticut
Camden County College, Blackwood, New Jersey
Colorado Northwestern Community College, Rangely, Colorado
Daytona Beach Community College, Daytona Beach, Florida
Greenville Technical Coolege, Greenville, South Carolina
Horry-Georgetown Technical College, Conway, South Carolina
Marshalltown Community College, Marshalltown, Iowa
Miami-Dade Community College, Miami, Florida
North Central Technical Institute, Wausau, Wisconsin

Oklahoma State Technical Institute, Okmulgee, Oklahoma
Pitt Technical Institute, Greenville, North Carolina
Red Wing Area Vocational Technical Institute, Red Wing, Minnesota
Tacoma Community College, Tacoma, Washington
Texas State Technical Institute, Waco, Texas
Utah Technical College, Provo, Utah
Walker State Technical College, Sumiton, Alabama

Many of these schools had to remove themselves from consideration as ECUT field-test sites because they could not complete the planning, gain approval, secure start-up funds, obtain instructors, and recruit students in the short time (less than one year) required for the field test to begin. Nearly all of the candidate sites are currently offering some of the ECUT courses - either included in another curriculum or in an adult education setting.

The four field-test sites that began offering the full ECUT curriculum to full-time students beginning in August/September 1979 are listed below:

Horry-Georgetown Technical College, Conway, South Carolina
ECUT Coordinator, Mr. Wade Harper

Horry-Georgetown Technical College is one of sixteen schools in the South Carolina Technical Education Campus system. The school is located in an area of the state where agriculture and tourism have a great impact. The school is relatively small but is experienced in offering vocational programs that include "hands-on" laboratory learning experiences. Existing courses that supported the ECUT program were Electronics, Solar, Air Conditioning/Refrigeration, Data Processing, and Physics. Thirty-one students enrolled in the first ECUT class in the fall of 1979, and 16 in the second class in 1980. Sixteen students from the first class were graduated in the summer of 1981. Graduates have gone to work at such places as South Carolina State Energy Extension Service and Horry County Energy Manager.

Marshalltown Community College, Marshalltown, Iowa
ECUT Coordinator, Mr. Arlen Hackbarth

Marshalltown Community College is a small community college in a rural area. The greatest strengths of this school are its experienced faculty and the involvement of local industry with the school. Being in a rural area and some distance from most prospective students, Marshalltown experienced difficulty in recruitment for this program. Eight students enrolled in the first ECUT class in the fall of 1979, and 15 in the second class in 1980. Six students were graduated from the first class in 1981, and these graduates have taken positions at such places as Landen-Landen Energy Systems.

Red Wing Energy Center, Red Wing, Minnesota
ECUT Coordinator, Ms. Pat Enz

The Red Wing Energy Center was established by the Red Wing Area Vocational Technical Center as an independent facility with all new faculty and labs. All personnel and facilities are under the control of the ECUT program director. The Red Wing Energy Center has four other energy-related programs underway. Red Wing enrolled 14 students in their first ECUT class, and 17 more in 1980. Eleven students were graduated from the 1979 class in the summer of 1981, and they all have received job offers from such employers as Gada Associates Consulting Engineers, Texas Instruments, Micoud-Cooley Engineering Consultants, Hallburg Consultants, Sperry Univac, Energy Value Consultants, and Kimmet, Jensen & Wegerer Engineers.

Tacoma Community College, Tacoma, Washington
ECUT Coordinator, Ms. Ivonna McCabe

Tacoma Community College is a large, established community college with 75% of their offerings being college-transfer courses. The ECUT program is the first technician program offered by Tacoma Community College; consequently, they had no equipment, labs, or instructors with technician experience. They overcame this obstacle because of a strong commitment by their president to the ECUT program and through heavy involvement and extremely good cooperation with local industry (some of their labs are taught in industry facilities). Another significant factor in the program success is the leadership provided by the ECUT program director, who has been very actively involved in recruitment and placement of students. Tacoma enrolled 14 students at the beginning of their first ECUT class in 1979 and 14 in 1980. The nine who were graduated from that first class received job offers from Tacoma City Light Company, Pittsburg Midwest Coal Liquefication, Clover Park School District, and Tacoma General Hospital.

Field-Test Workshops

The following workshops were held in the summer of 1979 for field-test coordinators and instructors from each of the potential field-test sites.

1. Unified Technical Concepts Workshop - June 27-28
   Camden County College, Blackwood, New Jersey
2. Microprocessor Workshop - July 10-12
   Boston, Massachusetts
3. Energy Courses Workshop - August 1-3
   TERC-SW Office, Waco, Texas
   - Fundamentals of Energy Technology
   - Energy Economics
   - Energy Production Systems

The purposes of the workshops were to familiarize the instructors with the course materials (including the laboratory activities) and to clarify the procedures and required data from the field tests. Representatives from the following schools attended these workshops.

Albuquerque Technical Vocational Institute
Anoka Area Vocational Technical Institute
Asnuntuck Community College
Camden County College
Colorado Northwestern Community College
Greenville Technical College
Hennepin County Area Vocational Technical Centers.
Horry-Georgetown Technical College
Indiana Vocational Technical College
Lansing Community College
Marshalltown Community College
Miami-Dade Community College

Midlands Technical College
916 Area Vocational Technical Institute
Red Wing Area Vocational Technical Institute
Rochester Area Vocational Technical Institute
Tacoma Community College
Utah Technical College at Provo

Another field-test workshop was held in the summer of 1980, in Dallas, Texas, for the coordinators and instructors of the four schools testing the entire ECUT curriculum. At this meeting, the project staff and the field-test representatives discussed the problems and successes in the first-year courses and critiqued the course materials developed on the project. Where available, copies of second-year courses were distributed and explained.

At other times during the project, a TERC-SW staff member visited the field-test sites and talked about the ECUT program with the school administration, coordinators, faculty and, most important, to the students.

In addition to providing valuable feedback for revisions to the courses/modules, the field-test schools suggested the following changes to the curriculum:

- Reduce three chemistry courses to two.
- Incorporate the eight UTC supplemental modules (described in the previous section of this report) into a technical math course, offered in the first term.
- Move UTC physics to begin the second term in the first year.
- Increase the depth and content of the Fundamentals of Energy Technology.
- Completely revise and update the content of the Electronic Devices and Systems course.
- Recommend Energy Audits course to be taken in the summer after the first or second year, preferably as a cooperative effort with an employer.

The critiques and recommendations from the field-test sites were the predominant factor in the revisions to the curriculum and course materials. Support from aggressive, cooperative schools such as these is an absolute necessity in the development and refinement of a new curriculum and instructional materials.

PROJECT VISIBILITY ACTIVITIES

To derive maximum impact from this project, the potential users of the ECUT curriculum and the developed instructional materials must learn about the project as early as possible. Potential users include postsecondary institutions offering technical training (for full two-year program offerings in energy or as isolated courses in related programs), community and adult education courses, retraining programs in industry, and certain high school courses.

The following activities were undertaken by the TERC-SW project staff to provide ECUT program visibility to potential users.

- The Project Director chaired the Nuclear Task Force at the National Energy Education, Business, and Labor Conference, Washington, DC, January 15-17, 1979, and during this conference distributed 800 copies of an information brochure describing the Energy Conservation-and-Use Technician program, its objectives, and tentative curriculum.
- Seven hundred copies of a booklet, Energy-Related Training Activities, An Assessment of Current Offerings Throughout the Country, were distributed. This booklet was a revised version of the Task A, Subtasks 2 and 3, report described earlier.
- Letters were sent to 1,312 selected two-year, postsecondary schools, informing them of the availability of the ECUT materials.
- "Technical Education to Meet New Demands in Energy," an article written by the Project Director, appeared in the May 1979 issue of Engineering Education, the Journal of the American Society for Engineering Education.
- The project staff conducted a meeting with 16 technical schools from the State of South Carolina to familiarize them with the project. This meeting was initiated by, and recommended to South Carolina schools by the South Carolina State Board for Technical and Comprehensive Education. One field-test site resulted from this meeting.
- The Project Director described the ECUT project and distributed ECUT information brochures at the June 1, 1979, meeting of the Southern States Energy Board.
- An informational leaflet describing the curriculum program was developed. Over 3,000 copies were printed and distributed for use in informational activities and in responding to inquiries.
- Project staff presented the ECUT program at an energy conference November 5-7, 1979, at Indiana University at South Bend.
- A paper entitled "UTC Physics - A Broad Technical Base for Energy Technicians" was presented to the January 1980 meeting of the American Association of Physics Teachers in Chicago by the Project Director;

Dr. Frank Pedrotti of the Physics Department, Marquette University; Dr. Leno S. Pedrotti, Chairman of the Physics Department at the U. S. Air Force Institute of Technology.

- The Project Director presented a description of the ECUT project to the American Vocational Association Energy Awareness Conference that took place January 29 through 31, 1980, in Arlington, Virginia.
- The Associate Project Director presented a paper entitled "Broad-based Curriculum for Training Energy Conservation-and-Use Technicians" at the National Conference on Meeting Energy Workforce Needs in February 1980. This conference was sponsored by the U. S. Office of Education's Energy and Education Action Center.
- The Associate Project Director made a presentation on the ECUT project and discussed the future of energy education in two-year postsecondary institutions at a February 8-9, 1980, Energy Management Conference at Edmonds Community College in Lynnwood, Wisconsin.
- The Project Director made a presentation of the ECUT project to the American Technical Education Association March 26-29, 1980, meeting in Columbus, Ohio.
- The project staff presented a description of the ECUT project at the 1980 Conference on Industrial Energy Conservation Technology meeting April 13 through 16, 1980, in Houston, Texas.
- Joyce Lain Kennedy, a syndicated columnist for "Careers," produced an article about energy technology on May 10, 1980. This article drew more than 300 inquiries, mostly from potential students, from throughout the United States. The students were given information about the ECUT programs at schools, and the schools were provided a list of the student inquiries.
- The Associate Project Director presented a paper entitled "Conservation/Management as Related to Education, Business, and Labor" at a May 1980 meeting in Red Wing, Minnesota. This meeting was the Energy Education Symposium.
- An article on the ECUT project was included in the November 1980 issue of the American Association of Junior Colleges newsletter, "Energy Currents."
- The Project Director presented a description of the ECUT project to the 1981 Concurrent Meeting of the National Network for Curriculum Coordination Centers and State Liaison Representatives in Atlanta, Georgia, July 14-16, 1981. Copies of course materials were distributed.
- Companion articles by the Project Director and Dr. Leno S. Pedrotti will appear in the 1982 edition of the Technician Education Yearbook. The titles of these articles are "Unified Technical Concepts in Physics - An Alternative Approach to the Teaching of Traditional Physics Courses in Engineering Technology Programs," and "A Broad Base Curriculum for Energy Technicians."

PROGRAM PLANNING GUIDE

A 175-Page ECUT Program Planning Guide* was prepared, reviewed, revised, and distributed to all participants at the regional diffusion/dissemination workshops. The purpose of the Guide is to describe Energy Conservation-and-Use Technology, identify job categories for technicians working in the field, and to assist planners, administrators, faculty, and industrial and community educators in establishing and conducting relevant training programs.

The Guide provides a model curriculum plan and suggests methods for adapting the modular materials to curricula tailored to specific locations or employer needs. Also included is information about educational facilities, equipment, staffing, and instructional materials needed for training technicians in the field.

The detailed course and module outlines and objectives revised from the Curriculum Development Guide have been included in an eighty-page appendix of the Planning Guide. This inclusion eliminates the necessity for continuing to make available the Development Guide.

Over 500 copies of the Curriculum Planning Guide has been distributed to workshop participants and other interested state planners and school representatives.

DISSEMINATION WORKSHOPS AND OTHER ACTIVITIES

Definitions of "visibility activities" and "dissemination activities" are needed for clarity in disucssion throughout this report. Visibility activities are those actions that provide information and create an awareness about the project and its products. Dissemination is the transfer of information about the curriculum and instructional materials to individuals or organizations that are interested in implementing one or more ECUT Courses.

*Available from the Center for Occupational Research and Development, 601 Lake Air Drive, Suite C, Waco, Texas 76710.

- Project staff visits to interested schools are dissemination activities; over 20 visits were made to schools by the staff to assist the schools in some area of program planning or decision-making.
- Coordination meetings with field-test site representatives are dissemination activities; four coordination meetings were held through the duration of the project.
- Phone calls with school planners and ECUT faculty are dissemination activities; the project staff spent hundreds of hours on phone calls to various schools to provide information, coordinate the supply of instructional modules, and assist in solving particular problems. A significant effort was also spent with employees and schools to identify employment opportunity for ECUT graduates.
- The distribution of the ECUT Curriculum Planning Guide was a dissemination activity; over 500 copies of the Guide have been distributed to schools and state education agencies. Because of the unexpectedly high demand for ECUT planning information, project funds to provide complimentary copies of the Planning Guide were nearly depleted by July 1981. After conferring with the ED Project Officer, the remaining funds for copies of the Guides were diverted to print a 12-page booklet about the ECUT Curriculum. Twenty-five hundred copies of this booklet (shown in Appendix D) have been printed; 1,000 have been distributed.

Regional Diffusion Workshops

A major dissemination effort of the project was the five Regional Diffusion Workshops. Ten thousand copies of workshop flyers (copy in Appendix E) were printed and distributed to schools, state education agencies, and employers of ECUT technicians. The five workshops were held at the locations and on the dates shown below.

- Minneapolis, Minnesota
  May 6 and 7, 1981
  36 attendees
- College Park, Maryland
  May 19 and 20, 1981
  49 attendees
- Atlanta, Georgia
  May 27 and 28, 1981
  31 attendees
- Denver, Colorado
  June 3 and 4, 1981
  39 attendees
- Honolulu, Hawaii
  June 18 and 19, 1981
  19 attendees

A typical agenda for the workshop is shown in Appendix F. Considerable time was spent the first afternoon of each workshop listening to ECUT employers (or potential employers) describe their needs in terms of number of jobs, and required tasks that ECUTs perform. It was felt that this type of emphasis was necessary and needed to be said by employers to give credibility to the employment needs and the broad, technical diversity required in the ECUT curriculum. Local speakers were enlisted from near the community where the workshop was held; and all industry speakers participated without an honorarium or travel reimbursement.

The greatest interest in presentations at the workshops was generated by the representatives from the field-test schools. Many of the participants' questions were answered by the personal testimonies of "what went well and what were the problems" at the pilot programs. Another agenda item of high interest to participants was the discussion on "Use of the ECUT Materials in Adult Education and Employer Retraining Programs."

Each participant completed a Workshop Critique and prepared a tentative ECUT dissemination strategy for his or her state. Most participants felt that the program had some applicability in their state and they planned to distribute the volume of material that they received. A workshop follow-up letter from the representative from California is included in Appendix G to indicate one response to the workshop.

A frequent comment on the Workshop Evaluation was "We will need to have you conduct periodic workshops for our faculty on the UTC Physics." In response to this perceived need TERC-SW (now the Center for Occupational Research and Development) has conducted two UTC workshops (July 8-9, 1981, and November 9-10, 1981), and plans to conduct two workshops each year in its location in Waco, Texas. A letter from a participant in the November 1981 workshop is shown in Appendix H.

CONCLUSIONS AND RECOMMENDATIONS

In recent years, curriculum development programs with potential of national significance have become very precious for two reasons. The first is because, if they are organized properly, with sufficient flexibility to permit them to be tailored to local needs, their adoption by institutions and employers will save much time, effort, and money by eliminating the need for each organization to completely "reinvent the wheel." Secondly, these national programs are precious because they are rare; the prospect of new vocational educational initiatives such as these being funded at the federal level is extremely doubtful in the next several years. With these thoughts in mind, one realizes that a discussion of the results and conclusions for this project must be more than statements that high-quality instructional programs and materials have been properly designed, developed, evaluated, revised, and disseminated. The importance of this project must be evaluated on the real impact that the project has made on technical education and the perceived impact that should be realized in the next few years.

CONCLUSIONS

- The Energy Conservation-and-Use Technician project has three major areas of national impact potential.

1. New Postsecondary Technician Programs in Energy Conservation-and-Use Technology:

   The following schools are currently offering energy-related curricula and courses using some or all of the ECUT materials:

   Tacoma Community College, Washington
   Red Wing Energy Education Center, Minnesota
   Horry-Georgetown Technical Education Center, South Carolina
   916 Area Vocational School, Minnesota
   Colorado Northwestern Community College, Colorado.
   Pitt Technical Community College
   Greenville Technical College, South Carolina
   Pitt Technical Institute, North Carolina

The following organizations have purchased complete sets of all the ECUT course materials and are reviewing them to determine which will be used in the near future:

Illinois Valley Community College
University of Hawaii
University of Alaska
California Department of Education
Hutchinson Area Vo-Tech School
Midwest Careers Institute
Northern Kentucky University
Utah Technical College
Alabama Technical College
College of Southern Idaho
Moraine Valley Community College
Western Iowa Technical College
Frederich Community College
The Indianhead VTAE District
Florida State University

As a result of attending the ECUT regional dissemination workshops held in May and June, 1981, representatives from the following states have indicated the possibility of all or part of the ECUT materials being used in schools within their state:

Minnesota	Wisconsin	Michigan	Iowa	Texas
Wyoming	Illinois	Maryland	New Jersey	Pennsylvania
Rhode Island	New Hampshire	Delaware	Ohio	N. Carolina
Florida	Arkansas	Kentucky	Georgia	S. Carolina
Tennessee	Alabama	Kansas	Virgin Is.	Mississippi
Indiana	Utah	Colorado	Idaho	Alaska
Nebraska	Washington	Arizona	New Mexico	California
Hawaii				

2. Use of ECUT Course Materials for Adult Education and Employer Retraining Courses

The most widespread use of ECUT materials for adult education courses has been at Rochester Area Vocational School, Minnesota (Ms. Jeanne Brownback, Energy Coordinator). The greatest use of ECUT materials for employer retraining has been at Los Alamos National Laboratory, New Mexico (Ms. Gloria Cordova).

As a result of attending the ECUT regional dissemination workshops, representatives from the following states have indicated the possibility of selected ECUT materials being used for adult and community education courses within their states:

Minnesota	Wisconsin	Michigan	Iowa	N. Carolina
Wyoming	Illinois	Maryland	New Jersey	S. Carolina
Rhode Island	New Hampshire	Delaware	Ohio	Mississippi
Florida	Arkansas	Kentucky	Georgia	Alaska
Tennessee	Alabama	Kansas	Virgin Is.	California
Indiana	Utah	Colorado	New Mexico	Texas
Nebraska	Washington	Arizona	Idaho	Pennsylvania
Hawaii				

3. Use of the ECUT Technical Core in Restructuring Engineering Curricula to Provide a Broad Technical Base -

The most far-reaching and important impact of the ECUT Project is the availability of an interdisciplinary, technical-core curriculum for training engineering technicians in a number of specialty areas such as:

Electronics
Computers
Laser/electro-optics
Biomedical equipment
Electromechanical
Robotics
Electrical power production
Production equipment maintenance
Building maintenance

This goal will also be the slowest to achieve. Although it was not a specific objective of this project, some work is already underway to indicate that schools will eventually utilize the "technical core" concept in technician curricula.

North Central Technical Institute, Wausau, Wisconsin, has begun to move toward an interdisciplinary curriculum for their Laser/Electro-Optics Technician program. Albuquerque Technical-Vocational Institute is seriously considering most of the ECUT core for their Electrical Power Production program. Tacoma Community College plans to implement other technician programs by changing the five-or-six specialty courses in their ECUT curriculum. Jackson Vocational-Technical School in Arkansas has indicated a desire to use most of the ECUT core materials in their Electromechanical Technology program.

The first step for a school to implement an interdisciplinary technician curriculum is to utilize the Unified Technical Concepts Physics. UTC is at the very heart of the technical core. The following schools and employers have sent one or more faculty representatives to CORD-sponsored UTC workshops in 1981:

Moraine Valley Community College, Illinois
Southern University of Shreveport, Louisiana
~~Parkland College, Illinois~~
Bee County College, Texas
College of Southern Idaho
Seward Community College, Kansas
Anoka AVTI, Minnesota
Prince George's Community College, Maryland
Honolulu Community College, Hawaii
Oklahoma City Jr College, Oklahoma
Daytona Beach Community College, Florida
Bainbridge Junior College, Georgia
Lewis & Clark State College, Idaho
Detroit Edison Company, Michigan
Gulf States Utility Company, Texas
South Carolina Electric and Gas Company
Salt River Project
Los Alamos National Laboratory

Two situations exist throughout the country that may cause many schools, interested in an ECUT program, to be very reluctant in implementing it quickly. One of these is the oscillatory nature of our country's sense of urgency related to energy conservation. When fuels are in short supply and energy prices rise, we react strongly to the need to save energy. However, when current supplies become more abundant and/or the public becomes accustomed to the higher prices, apathy sets in and energy conservation no longer seems as important.

The second situation relates to the perceived inadequacy of educational funds at federal, state, and local levels. In this present climate (which may persist for several years) new educational programs and initiatives in education are all but impossible in many states. Even travel to curriculum workshops is limited or denied in some states.

RECOMMENDATIONS

- The time schedule for this project was necessarily limited to three years. In order to have field-test sites for the entire two-year curriculum, schools had ~~to~~ begin teaching the ECUT courses in less than a year from the beginning of the project. There is no way that all the sequential events called for in the first year of the project can be attended properly. It is recommended that in the future similar projects be scheduled for a five-year duration.
- Considerable interest in the ECUT materials has been demonstrated by schools and employers. Additional dissemination efforts are required to move these interests into high-quality course and program offerings. Particularly important to the ECUT Project Director is the continued effort to disseminate the technical core concept in technician curricula. This will be a slow process, but one that leads to a goal that is worthy of the task. Support for this dissemination effort is greatly needed.

APPENDIX A

PROJECT ADVISORY COMMITTEE

APPENDIX A

PROJECT ADVISORY COMMITTEE

Mr. Ronald Beckman, Energy Programming Coordinator & Supervisor of Technical Education
North Central Technical Institute
Wausau, Wisconsin

Mr. Sam Borden
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Indiana Vocational Technical College
Terre Haute, Indiana

Mr. O. Charles Carter, Jr.
Manager of Consumer Services
Dallas Power & Light Company
Dallas, Texas

Dr. Ed Darby, Assistant Director
Academic Affairs
Oklahoma State Tech
Okmulgee, Oklahoma

Dr. Alan Day
Greenville Technical College
Greenville, South Carolina

Mr. Robert D. Dillsaver
Vice President of Employee Relations
Cities Service Company
Tulsa, Oklahoma

Ms. Pat Enz
Director of Energy Education Center
Red Wing Area Vocational Technical Institute
Red Wing, Minnesota

Mr. W. Scott Fellows
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Southern States Energy Board
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Mr. John J. Gammuto
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Mr. Arlan Hackbarth
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Marshalltown Community College
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Dr. Jim Hahesy, Director
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Asnuntuck Community College
Enfield, Connecticut

Mr. Gene Hildman, Chief Engineer
Scott & White Memorial Hospital
Temple, Texas

Mr. Donald J. Hosterman
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Dr. Robert D. Krienke
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Mr. John David Lawrence, President
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Elkhart, Indiana

Mr. Bill Matheny
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Mr. Charles Maybeck
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Dr. Faye McQuiston, Chairman
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Dr. George Mehallis
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Mr. Tom Reid
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Horry-Georgetown Technical College
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Mr. Bill Robinson
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Dr. Richard Rounds, Director
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Mr. Martin Schwartz
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Provo, Utah

APPENDIX B

EQUIPMENT USED BY ECUTs

APPENDIX B

TYPES OF EQUIPMENT, BY CATEGORY, WITH WHICH ECUTs WORK

INSTRUMENTATION AND CONTROLS

Rotameters
Differential Pressure Devices
Pitot Tubes
Turbine Meters
Anemometers
Open Channel Wires
Magnetic Flowmeters
Liquid-in-Glass Thermometers
Liquid-Filled Dial Thermometers
Bimetallic Thermometers
Crayon Temperature Indicators
Liquid Temperature Indicators
Pellet Temperature Indicators
Resistance Temperature Indicators
Microcomputers
Thermocouples
Optical Pyrometers
Total Radiation Pyrometers
Manometers
Limp Diaphragm Gages
Bourdon and Bellows Gages
Sight Gages
Bubble Tubes
Float/Buoyancy Meters
Capacitance-Level Gages
Direct Current Meters
Alternating Current Meters
Multimeters
Gas Analyzers
Servos
Solenoids

ELECTROMECHANICAL DEVICES

Motor Speed Controllers
Motor Starters
Autotransformers
Servos
Motors, A.C., D.C,
Generators, A.C., D.C.
Relays
Buzzers
Vibrators
Horns
Brushes
Contacts
Starting Capacitors

ELECTROMECHANICAL DEVICES, continued.

Meter Movements/Meters
Servomechanisms
Switches
Fuses

MECHANICAL DEVICES AND SYSTEMS

Belts
Sheaves
Chains
Sprockets
Gears
Transmissions
Speed Reducers
Shafts
Couplings and Joints
Bearings
Seals
Gaskets
O-Rings
Clutches
Linkages
Cams and Cam Followers
Fans and Blowers
Valves
Packing

THERMAL ENERGY PRODUCTION AND CONVERSION DEVICES/SYSTEMS

Boilers
Superheaters
Turbines
Solar Hot Water
Solar Hot Air
Heat Pumps
Waste Heat Recovery Systems
HVAC Systems
Lighting/Illumination
Heat Exchangers

HAND AND POWER TOOLS

Conventional Hand Tools:
- Hammers
- Pliers
- Screwdrivers
- Common Wrenches
- Torque Wrenches

Hand Power Tools:
- Drills
- Sanders
- Grinders
- Saws

Bench & Floor Power Tools:
- Drill Presses
- Bench Grinders/Polishers
- Mills
- Lathes
- Surfacers/Planers
- Vises
- Saws

Metal Working Tools:
- Hand Breaks
- Hand Shears
- Notchers

Precision Measuring Devices:
- Levels
- Squares
- Rules
- Micrometers
- Radius Gages
- Other Dial Type Gages

Drawing Tools:
- T-Squares
- Triangles
- Compasses
- Dividers
- Templates
- Curves
- Marking Instruments
- Lettering Devices

ELECTRONIC DEVICES AND SYSTEMS

- Resistors
- Potentiometers
- Capacitors
- Inductors
- Transformers
- Chokes
- Rectifiers
- Diodes

ELECTRONIC DEVICES AND SYSTEMS, continued.

- Transistors
- SCRs
- Triacs
- Vacuum Tubes
- Gaseous Tubes
- Gates
- Inverters
- LEDs
- CRTs
- Oscilloscopes
- Vacuum Tube Multimeters
- Logic Analyzer
- Transistor Digital Multimeters
- Oscillators
- Frequency Counters
- Volt-Ohmmeter
- Amp Probe
- Bridges
- Photovoltaic Cells
- Photoconductive Cells
- Batteries

FLUID POWER SYSTEMS

- Pressure Measuring Devices
- Pumps
- Compressors
- Motors (Fluid)
- Cylinders
- Limited Action Rotary Devices
- Hoses
- Pipes and Tubing
- Connectors
- Fittings
- Valves
- Valve Actuators
- Accumulators
- Reservoirs
- Auxiliary Tanks
- Separators
- Filters
- Strainers
- Lubricators
- Regulators
- Oil Heaters
- Dryers

RESEARCH AND DEVELOPMENT LABORATORY EQUIPMENT

Hot Cells
Fuel Cells
Glove Boxes
Master-Slave Manipulators
Intruder Sensor Systems
Detection Systems
Vertical Axis Turbines
Vacuum Recovery Systems
Purification Systems
Spectroscopy Systems
Photovoltaic Generators
Pressure Systems
Computers
Minicomputers
Microprocessors
Graphic Display Devices
Assay Instrumentation
Pulsed Neutron Generators
Solar Tracing and Collection Systems
Seismic Sensors
Seismometers
Ion Implantation Devices
Waste Vitrification Furnaces
Magma Effects Simulation Furnaces
Thermoelectric Generators
Cryogenic Systems
Superconducting Magnets
Silicon Solar Cells
Electro-Optic Fibers and Couplers
Explosives & Explosive Devices

ELECTRICAL POWER AND ILLUMINATION DEVICES

Wiring/Cables
Switching Gears
Fuse Boxes/Fuses
Circuit Breaker Boxes/Circuit Breakers
Conduit
Lamp Fixtures
Ballasts/Starters
Lamps/Incandescent
Lamps/Fluorescent
Lamps/Gas Discharge
Solid State Dimmers
Timers
Connectors
Convenience Outlets
Transformers

APPENDIX C

CURRICULUM DESIGN

ENERGY CONSERVATION-AND-USE TECHNICIAN
RECOMMENDED CURRICULUM
QUARTER SYSTEM

	Lec.	Lab.	Contact Hours
First Quarter			
Chemistry for Energy Technology I	3	3	6
*Fundamentals of Energy Technology	3	0	3
Technical Math I	3	0	3
Microcomputer Operations	3	3	6
Technical Communications	4	0	4
	16	6	22
Second Quarter			
Unified Technical Concepts I (Physics)	3	6	9
Chemistry for Energy Technology II	3	3	6
*Energy Economics	3	0	3
Technical Math II	3	0	3
Schematic and Blueprint Reading	1	3	4
	13	12	25
Third Quarter			
Unified Technical Concepts II (Physics)	3	6	9
*Energy Production Systems	3	0	3
Mechanical Devices and Systems	3	3	6
Fundamentals of Electricity and Electronics	3	3	6
	12	12	24
Fourth Quarter			
Unified Technical Concepts III (Physics)	3	6	9
Electromechanical Devices	3	3	6
Electronic Devices and Systems	4	4	8
Elective	3	0	3
	13	13	26
Fifth Quarter			
Electrical Power and Illumination Systems	3	3	6
Microcomputer Hardware	3	3	6
Heating, Ventilating and Air Conditioning	4	4	8
*Energy Conservation	3	3	6
	13	13	26
Sixth Quarter			
Fluid Power Systems	3	3	6
*Energy Audits	2	4	6
Instrumentation and Controls	3	3	6
*Codes and Regulations	3	3	6
	11	13	24

*Technical specialty courses

The Energy Conservation-and-Use Technician curriculum is a broad-based, technical curriculum organized around core courses and technical specialty courses. The core area comprises 82% of the total curriculum and contains both technical support courses and courses that develop the systems-oriented interdisciplinary skills. The specialty area contains courses that are related specifically to the needs of an energy technician. Technical specialty courses are marked with an asterisk.

ENERGY CONSERVATION-AND-USE TECHNICIAN
RECOMMENDED CURRICULUM
SEMESTER SYSTEM

First Semester	Lec.	Lab.	Contact Hours
Unified Technical Concepts I (Physics)	3	6	9
Chemistry for Energy Technology I	2	2	5
Technical Math I	2	0	2
Fundamentals of Energy Technology	2	0	2
Microcomputer Operations	3	3	6
	12	11	23

Second Semester	Lec.	Lab.	Contact Hours
Unified Technical Concepts II (Physics)	3	6	9
Chemistry for Energy Technology II	2	2	5
Technical Math II	2	0	2
Energy Production Systems	2	0	2
Fundamentals of Electricity and Electromechanical Devices	3	4	7
	12	12	25

Third Semester	Lec.	Lab.	Contact Hours
Mechanical and Fluid Systems	3	4	7
Electrical Power and Illumination Systems	2	2	4
Electronic Devices and Systems	3	3	6
Schematic and Blueprint Reading	1	2	3
Energy Conservation	2	2	4
	11	13	24

Fourth Semester	Lec.	Lab.	Contact Hours
Codes and Regulations	2	2	4
Heating, Ventilating and Air-Conditioning	3	3	6
Technical Communications	3	0	3
Instrumentation and Controls	3	3	6
Energy Economics and Audits	3	3	6
	14	11	25

RELATIONSHIP BETWEEN SEMESTER COURSES AND QUARTER COURSES

ENERGY CONSERVATION-AND-USE TECHNOLOGY CURRICULUM

Quarter System

Course	Contact Hrs/Wk	Wks of Instr	Total Contact Hrs per Course	Total Contact Hrs per Cluster
Unif. Tech. Con. I	9	10	90	
Unif. Tech. Con. II	9	10	90	
Unif. Tech. Con. III	9	10	90	270
Chem. for Energy Technology I	6	10	60	
Chem. for Energy Technology II	6	10	60	120
Fund. of Engy. Tech.	3	10	30	30
Tech. Math I	3	10	30	
Tech. Math II	3	10	30	60
Microcomp. Opr.	6	10	60	
Microcomp. Hdwe.	6	10	60	
Instrum. & Ctrl.	6	10	60	180
Energy Economics	3	10	30	
Energy Audits	6	10	60	90
Fund. of Electricity & Electronics	6	10	60	
Electromech. Dev.	6	10	60	120
Engy. Prod. Systems	3	10	30	30
Mech. Dev. & Syst.	6	10	60	
Fluid Systems	6	10	60	120
Electronic Dev. & Systems	8	10	80	80
El. Pwr. & Illum. Systems	6	10	60	60
Schem. & B.P. Rdg.	4	10	40	40
Engy. Consv.	6	10	60	60
HVAC	8	10	80	80
Tech. Comm.	4	10	40	40
Codes & Regs.	6	10	60	60
TOTAL CONTACT HOURS				1440

Semester System

Course	Contact Hrs/Wk	Wks of Instr	Total Contact Hrs per Course	Total Contact Hrs per Cluster
Unif. Tech. Con. I	9	15	135	
Unif. Tech. Con. II	9	15	135	270
Chem. for Energy Technology I	4	15	60	
Chem. for Energy Technology II	4	15	60	120
Fund. of Engy. Tech.	2	15	30	30
Tech. Math I	2	15	30	
Tech. Math II	2	15	30	60
Microcomp. Opr. (½ Microcomp. Hdwe.)	6	15	90	
Instrum. & Ctrl. (½ Microcomp. Hdwe.)	6	15	90	180
Engy. Econ. & Audits	6	15	90	90
Fund. of Electricity & Electromech. Dev.	7	15	105	105
Engy. Prod. Systems	2	15	30	30
Mech. & Fluid Syst.	7	15	105	105
Electronic Dev. & Systems	6	15	90	90
El. Pwr. & Illum. Systems	4	15	60	60
Schem. & B.P. Rdg.	3	15	45	45
Engy. Consv.	4	15	60	60
HVAC	6	15	90	90
Tech. Comm.	3	15	45	45
Codes & Regs.	4	15	60	60
TOTAL CONTACT HOURS				1440

FUNDAMENTALS OF ENERGY TECHNOLOGY

Fundamentals of Energy Technology is designed to give the student an overview of the field of energy conservation and use and to provide descriptions of job functions typical to energy technicians. The course material is organized to show the compatibility of the total curriculum and the purpose of the approach chosen.

Module EF-01	Energy Technology
Module EF-02	Sources of Energy: I
Module EF-03	Sources of Energy: II
Module EF-04	Uses of Energy
Module EF-05	Energy Analysis
Module EF-06	Energy and the Environment
Module EF-07	Energy Resource Guide

ENERGY ECONOMICS

Energy Economics is a course designed to familiarize the student with the energy-conserving and cost-saving measures that are available, as well as the analysis techniques that are necessary for accurate evaluation of energy projects.

Module EE-01	Fundamentals of Energy Cost Analysis
Module EE-02	Financial Parameters of Energy Economics
Module EE-03	Financial Techniques of Energy Economics
Module EE-04	Economics of Energy Alternatives
Module EE-05	Economic Analysis and Energy Conservation Projects

ENERGY PRODUCTION SYSTEMS

Energy Production Systems is an in-depth technical study of processes and equipment used to convert energy resources (such as geothermal and the sun) and fuels (such as coal and natural gas) into useful energy forms, such as electricity, heat and motion or light. This course will enable the Energy Conservation-and-Use Technician to select optimum energy sources and equipment for maximum economy, availability, efficiency and/or environmental quality.

Module EP-01	Generation of Steam and Hot Water, Using Solid Fuels
Module EP-02	Generation of Steam and Hot Water, Using Liquid and Gaseous Fuels
Module EP-03	Generation of Steam, Hot Water, and Hot Air, Using Solar Collectors
Module EP-04	Generation of Steam and Hot Water, Using Nuclear and Experimental Power Sources
Module EP-05	Combustion Engines

Module EP-06 Turbines
Module EP-07 Production of Electricity

ENERGY CONSERVATION

Energy Conservation is designed to give the student technical knowledge and specific skills required to perform conservation measures relative to the most common energy uses. The student will learn and utilize the basic principles of energy conservation and efficiency.

Module EC-01	Energy Conservation - An Introduction
Module EC-02	Conservation Principles and Efficiency Measurements - Space Heating
Module EC-03	Conservation Principles and Efficiency Measurements - Space Cooling
Module EC-04	Conservation Principles and Efficiency Measurements - Hot Water and Steam Supply Systems
Module EC-05	Conservation Principles and Efficiency Measurements - Illumination
Module EC-06	Conservation Principles and Efficiency Measurements - Electric Motors
Module EC-07	Conservation Principles and Efficiency Measurements - Building Construction

ENERGY AUDITS

This course provides an overview of the purpose, objectives and mechanics of the energy audit process. Full background and procedural instructions precede case studies and laboratory practice in auditing. Finally, audit analyses are undertaken, with student recommending remedial actions based on analyses of his or her practice audits.

Module EA-01	Total Energy Management
Module EA-02	Elements of an Energy Audit
Module EA-03	Energy Audit Procedures and Analyses
Module EA-04	Building Systems
Module EA-05	Lighting Systems
Module EA-06	Auditing HVAC Systems - Part I
Module EA-07	Auditing HVAC Systems - Part II
Module EA-08	Auxiliary Equipment Systems
Module EA-09	Process Energy Systems
Module EA-10	Renewable Resource Applications
Module EA-11	Energy Audit Workbook

HEATING, VENTILATING, AND AIR CONDITIONING

This course is designed to develop an understanding of air conditioning and heating systems and their characteristics, applications, and limitations. The intent of this course is to present the basics of such systems and factors affecting the selection and efficient operation of both commercial and residential heating and air conditioning equipment.

Module HC-01	Basic Refrigeration Cycle
Module HC-02	System Types
Module HC-03	Refrigeration Equipment
Module HC-04	Residential Heating Equipment
Module HC-05	Boilers for Heating Applications
Module HC-06	Piping
Module HC-07	Air Handling Equipment
Module HC-08	Psychrometrics

MICROCOMPUTER OPERATIONS

This course covers the operation and programming of microcomputers. The first part of the course concentrates on general concepts such as computer codes, binary arithmetic and the major parts of most computers. The small microcomputer systems are studied and applied to typical energy-related data-gathering and control problems. In the third part of the course, a larger, disk-based system is used. Its operation and the kinds of software it uses are studied and applied to energy conservation. Finally, students learn the elements of BASIC programming.

Module MO-01	Computer Codes
Module MO-02	Microcomputer Architecture
Module MO-03	Microcomputer Applications
Module MO-04	Disk-Based Operations
Module MO-05	Energy Applications of Microcomputers
Module MO-06	Introduction to BASIC
Module MO-07	BASIC Programming

MICROCOMPUTER HARDWARE

This course begins with an introduction to integrated circuit logic and a discussion of the common electrical and logical digital interfacing techniques. Specific techniques for getting both digital and analog data into and out of microcomputers are surveyed. Applications of these techniques to actual control problems are illustrated. Finally, data communication ideas and microcomputer troubleshooting techniques are covered.

Module MH-01	Digital Components
Module MH-02	Semiconductor Logic Families
Module MH-03	Input/Output Devices and Techniques
Module MH-04	Analog/Digital Conversion
Module MH-05	Data Communication
Module MH-06	Bus Systems
Moudle MH-07	Troubleshooting Microcomputer Components

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ELECTRONIC DEVICES AND SYSTEMS

Electronic Devices and Systems is designed to provide the student with a working knowledge of modern electronic devices and the circuits in which they are employed. Electronic troubleshooting techniques are stressed throughout the course. Topics presented include rectifiers, transistors, SCRs and triacs, vacuum and gaseous tubes, filters, amplifier circuits, operational amplifiers, noise reduction, ditigal circuits and display devices.

Module ED-01	Active Electrical Devices
Module ED-02	Electronic Analog Circuits
Module ED-03	Electronic Digital Circuits
Module ED-04	Input-Output Devices
Module ED-05	Analog Systems
Module ED-06	Digital Systems

ELECTRICAL POWER AND ILLUMINATION

This course is designed to provide the student with a practical knowledge of electrical power, distribution systems, and illumination systems. In addition, the students also practice electrical measurement, wiring methods, illumination measurement, circuit control - and are provided with an overview of the parts of the electrical distribution system.

Module PI-01	Efficiencies of Electrical Power Distribution Systems
Module PI-02	Electrical Power Transmission and Distribution
Module PI-03	Industrial Electrical Distribution
Module PI-04	Residential Electrical Distribution
Module PI-05	Electrical Energy Management
Module PI-06	Fundamentals of Illumination
Module PI-07	Light Sources
Module PI-08	Efficiency in Illumination Systems

TECHNICAL COMMUNICATIONS

The ability to write and speak well is important not only for the transfer of information; writing capabilities, as well as speaking expertise, often have an effect on the employee's advancement. This course, Technical Communications, shows the technician how to develop ideas in a clear, organized fashion. The exercises included in each module will help the student put new skills into practice.

Module TC-01	Introducing Technical Communications
Module TC-02	Conducting and Reporting Research
Module TC-03	Writing Outlines and Abstracts
Module TC-04	Writing Definitions
Module TC-05	Describing Mechanisms

Module TC-06 Describing a Process
Module TC-07 Performing Oral and Visual Presentations
Module TC-08 Preparing a Final Report

MECHANICAL DEVICES AND SYSTEMS

Mechanical Devices and Systems is an in-depth study of the principles, concepts and applications of various mechanisms that may be encountered in industrial application of energy use and conservation. The mechanical components and systems are divided into eight modules of instruction, covering operational procedures, uses, maintenance, troubleshooting, and repair and replacement procedures. The procedure or application portion of the modules will emphasize practical maintenance and installation of equipment and selection and specification of proper replacement components from manufacturers' catalogs.

Module MS-01 Belt Drives
Module MS-02 Chain Drives
Module MS-03 Gear Drives
Module MS-04 Drive Train Components I
Module MS-05 Drive Train Components II
Module MS-06 Linkages
Module MS-07 Fans and Blowers
Module MS-08 Valves

ELECTROMECHANICAL DEVICES

Electromechanical Devices is designed to provide the student with a working knowledge of control elements in electrical circuits, transformers, motors and generators. Topics presented include switches, circuit breakers, relays, fuses, transformers, d.c. and a.c. motors, and generators.

Module EM-01 Electromechanical Devices - An Introduction
Module EM-02 Control Elements in Electrical Circuits
Module EM-03 Transformers
Module EM-04 Generators and Alternators
Module EM-05 D.C. Motors and Controls
Module EM-06 A.C. Motors and Controls
Module EM-07 Synchromechanisms

INSTRUMENTATION AND CONTROLS

Instrumentation and Controls is designed to provide the student with practical knowledge and skills in the specification, use and calibration of measuring devices and the principles and applications of automatic control processes. The course stresses the integration of knowledge gained in pre-

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vious courses through the detailed examination of control systems for electrical power production, heating, air conditioning, and manufacturing.

- Module IC-01 Principles of Process Control
- Module IC-02 Instruments for Fluid Measurements - Pressure and Level
- Module IC-03 Fluid Flow Measurement
- Module IC-04 Instruments for Temperature Measurement
- Module IC-05 Instruments for Mechanical Measurement
- Module IC-06 Pneumatic Controls
- Module IC-07 Automatic Control Systems
- Module IC-08 Boiler and Other Special Control Systems

FLUID POWER SYSTEMS

Fluid Power Systems is designed to give the student an overivew of fluid power technology and a working knowledge of each of the components used in fluid power circuits. Hydraulic and pneumatic systems will be discussed, with emphasis placed on troubleshooting and maintenance procedures involved in each. Topics presented will include fundamentals of fluid dynamics, conventional fluid circuits, and fluid power components.

- Module FL-01 Introduction and Fundamentals of Fluid Power
- Module FL-02 Fluid Power Properties and Characteristics
- Module FL-03 Fluid Storage, Conditioning, and Maintenance
- Module FL-04 Pumps and Compressors
- Module FL-05 Actuators and Fluid Motors
- Module FL-06 Fluid Distribution and Control Devices
- Module FL-07 Fluid Circuits
- Module FL-08 Troubleshooting Fluid Circuits

CHEMISTRY FOR ENERGY TECHNOLOGY

Chemistry for Energy Technology is a course designed with a special emphasis on all aspects of chemistry as it relates to the work of an energy technician. The basic chemistry information and techniques presented in the 11 modules of this course have been deemed necessary for the applications that will be encountered by the energy technicians.

BOOK I

- Module CH-01 Safety in Chemical Operations
- Module CH-02 Structure of Matter
- Module CH-03 Chemical Equations and Calculations
- Module CH-04 Refrigeration, Gases, Air Pollution
- Module CH-05 Solutions

BOOK II

Module CH-06	Corrosions and Electrochemistry
Module CH-07	Metals and Ceramics
Module CH-08	Thermodynamics and Thermochemistry
Module CH-09	Fuels
Module CH-10	Plastics, Adhesives, and Lubricants
Module CH-11	Nuclear Chemistry

APPENDIX D

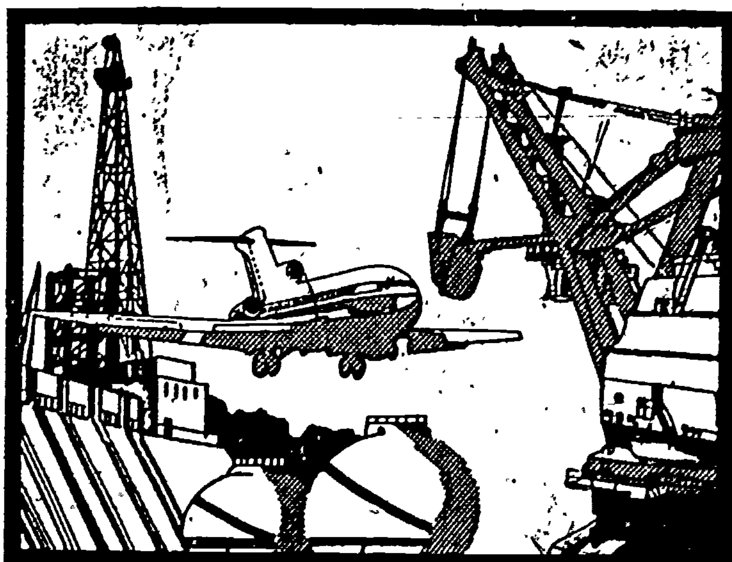
ECUT INFORMATION BOOKLET

ORD

CENTER FOR OCCUPATIONAL RESEARCH AND DEVELOPMENT
601 Lake Air Drive • Waco, Texas 76710 • Telephone (817) 772-8756

ENERGY TECHNOLOGY

CONSERVATION AND USE



Two-Year Postsecondary Curriculum and Instructional Materials

CORD CENTER FOR OCCUPATIONAL RESEARCH AND DEVELOPMENT
601 Lake Air Drive, Waco, Texas 76710

The Center for Occupational Research and Development (CORD), an independent, nonprofit organization, was established in 1979 to conduct research and development activities and disseminate curricula for technical and occupational education and training.

CORD was created through a reorganization of Technical Education Research Centers (TERC). The entire staff, facilities, and expertise of TERC-SW have been made available to CORD in its operation as an affiliate organization to TERC.

Institutions and employers are providing technical and occupational educational programs to prepare and retrain men and women for careers in new and rapidly growing areas of business and industry. Frequently, organizations that provide training do not have the expertise or inclination to conduct the research and development needed for relevant educational curricula. CORD serves as a catalyst in fostering interaction between business, education, labor, and government to anticipate and identify occupational needs and to assist employers and schools in implementing educational programs for those who seek careers in these occupational areas.

In its conduct of specific projects, CORD receives financial support in the form of grants or contracts from federal, state, and local government agencies. Equally important to the operation of CORD is the financial support provided by grants or contracts from private foundations, educational institutions, and industry.

The mission of CORD is complex and challenging — we sincerely request your aid and assistance in accomplishing this mission.

ENERGY... AN EMERGING TECHNOLOGY

Energy is no longer a simple issue. As energy industries expand, technical occupations associated with energy production, conservation, and utilization will change dramatically.

Modern equipment used in homes, businesses, institutions, and factories is complex. This equipment typically consists of systems that utilize combinations of mechanical, electrical, thermal, fluidal and/or optical components. Frequently these systems are controlled by electronic computers or microprocessors.

A new generation of "systems-oriented" technicians is needed to develop, install, operate, maintain, and repair this type of equipment. Narrowly-trained specialists are no longer sufficient or adequate for these tasks. The demand of this changing technology is for interdisciplinary technicians possessing combinations of technical skills and knowledge.

Career Opportunities

Energy technicians will be needed in a variety of occupations, such as:

- In research and development labs as a support to engineers and scientists,
- in power plants and factories to develop and maintain production equipment,
- in service organizations as energy audit technicians,
- in businesses, institutions, hotels, and apartments for responsibilities in maintaining plant equipment,
- and in sales and installation of new, energy-related equipment such as solar heating or electric conversion systems.

Training Programs and Materials

Energy Conservation-and-Use Technicians can now be trained or have their skills upgraded through the use of a two-year curriculum, training programs, or instructional materials developed and tested by the Center for Occupational Research and Development (formerly Technical Education Research Center — Southwest). Funding was provided through a contract with the U. S. Department of Education, Office of Vocational and Adult Education.

Two-year postsecondary institutions can implement the entire curriculum as recommended in this booklet for either the quarter or semester systems, or they can "tailor" it to local and/or regional needs. The flexibility of the modularized instructional materials offers this advantage to all schools.

In addition, many courses within the ECUT curriculum are ideal for use in continuing adult education, by industry training personnel, and for community consumer energy awareness classes.

ENERGY CONSERVATION-AND-USE TECHNOLOGY
COURSE AND MODULE TITLES

FUNDAMENTALS OF ENERGY TECHNOLOGY $17.50

Fundamentals of Energy Technology is designed to give the student an overview of the field of energy conservation and use and to provide descriptions of job functions typical to energy technicians. The course material is organized to show the compatibility of the total curriculum and the purpose of the approach chosen.

Module EF-01	Energy Technology
Module EF-02	Sources of Energy: I
Module EF-03	Sources of Energy: II
Module EF-04	Uses of Energy
Module EF-05	Energy Analysis
Module EF-06	Energy and the Environment
Module EF-07	Energy Resource Guide

ENERGY ECONOMICS $12.50

Energy Economics is a course designed to familiarize the student with the energy conserving and cost saving measures that are available, as well as the analysis techniques that are necessary for accurate evaluation of energy projects.

Module EE-01	Fundamentals of Energy Cost Analysis
Module EE-02	Financial Parameters of Energy Economics
Module EE-03	Financial Techniques of Energy Economics
Module EE-04	Economics of Energy Alternatives
Module EE-05	Economic Analysis and Energy Conservation Projects

ENERGY PRODUCTION SYSTEMS $17.50

Energy Production Systems is an in-depth technical study of processes and equipment used to convert energy resources (such as geothermal and the sun) and fuels (such as coal and natural gas) into useful energy forms, such as electricity, heat, and motion or light. This course will enable the Energy Conservation-and-Use Technician to select optimum energy sources and equipment for maximum economy, availability, efficiency, and/or environmental quality.

Module EP-01	Generation of Steam and Hot Water, Using Solid Fuels
Module EP-02	Generation of Steam and Hot Water, Using Liquid and Gaseous Fuels
Module EP-03	Generation of Steam, Hot Water, and Hot Air, Using Solar Collectors
Module EP-04	Generation of Steam and Hot Water, Using Nuclear and Experimental Power Sources
Module EP-05	Combustion Engines
Module EP-06	Turbines
Module EP-07	Production of Electricity

ENERGY CONSERVATION $17.50

Energy Conservation is designed to give the student technical knowledge and specific skills required to perform conservation measures relative to the most common energy uses. The student will learn and utilize the basic principles of energy conservation and efficiency.

Module EC-01	Energy Conservation — An Introduction
Module EC-02	Conservation Principles and Efficiency Measurements — Space Heating
Module EC-03	Conservation Principles and Efficiency Measurements — Space Cooling
Module EC-04	Conservation Principles and Efficiency Measurements — Hot Water and Steam Supply Systems
Module EC-05	Conservation Principles and Efficiency Measurements — Illumination
Module EC-06	Conservation Principles and Efficiency Measurements — Electric Motors
Module EC-07	Conservation Principles and Efficiency Measurements — Building Construction

ENERGY AUDITS $27.50

This course provides an overview of the purpose, objectives, and mechanics of the energy audit process. Full background and procedural instructions precede case studies and laboratory practice in auditing. Finally, audit analyses are undertaken, with student recommending remedial actions based on analyses of his or her practice audits.

Module EA-01	Total Energy Management
Module EA-02	Elements of an Energy Audit
Module EA-03	Energy Audit Procedures and Analyses
Module EA-04	Building Systems
Module EA-05	Lighting Systems
Module EA-06	Auditing HVAC Systems — Part I
Module EA-07	Auditing HVAC Systems — Part II
Module EA-08	Auxiliary Equipment Systems
Module EA-09	Process Energy Systems
Module EA-10	Renewable Resource Applications
Module EA-11	Energy Audit Workbook

TECHNICAL SUPPORT COURSES

The following Support Courses have been developed by CORD/TERC-SW as a part of the broad technical-based, interdisciplinary curriculum on the Energy Conservation-and-Use project. However, because of the nature of the contents of these courses, they may be used in a variety of technical programs. As an example, Technical Communications could be utilized in programs such as Nuclear Technology and Laser/Electro-Optics.

(continued on page 6)

ENERGY CONSERVATION—AND—USE TECHNICIAN RECOMMENDED CURRICULUM

QUARTER SYSTEM

FIRST QUARTER	Lec.	Lab.	Contact Hours
Chemistry for Energy Technology I	3	3	6
Fundamentals of Energy Technology	3	0	3
Technical Math I	3	0	3
Microcomputer Operations	3	3	6
Technical Communications	4	0	4
	16	6	22

SECOND QUARTER	Lec.	Lab.	Contact Hours
Unified Technical Concepts I (Physics)	3	6	9
Chemistry for Energy Technology II	3	3	6
Energy Economics	3	0	3
*Technical Math II	3	0	3
*Schematic and Blueprint Reading	1	3	4
	13	12	25

THIRD QUARTER	Lec.	Lab.	Contact Hours
Unified Technical Concepts II (Physics)	3	6	9
Energy Production Systems	3	0	3
Mechanical Devices and Systems	3	3	6
*Fundamentals of Electricity and Electronics	3	3	6
	12	12	24

FOURTH QUARTER	Lec.	Lab.	Contact Hours
Unified Technical Concepts III (Physics)	3	6	9
Electromechanical Devices	3	3	6
Electronic Devices and Systems	4	4	8
Elective	3	0	3
	13	13	26

FIFTH QUARTER	Lec.	Lab.	Contact Hours
Electrical Power and Illumination Systems	3	3	6
Microcomputer Hardware	3	3	6
Heating, Ventilating, and Air Conditioning	4	4	8
Energy Conservation	3	3	6
	13	13	26

SIXTH QUARTER	Lec.	Lab.	Contact Hours
Fluid Power Systems	3	3	6
Energy Audits	2	4	6
Instrumentation and Controls	3	3	6
*Codes and Regulations	3	3	6
	11	13	24

SEMESTER SYSTEM

FIRST SEMESTER	Lec	Lab	Contact Hours
Unified Technical Concepts I (Physics)	3	6	9
Chemistry for Energy Technology I	3	2	5
Technical Math I	2	0	2
Fundamentals of Energy Technology	2	0	2
Microcomputer Operations	3	3	6
	13	11	24

SECOND SEMESTER	Lec	Lab	Contact Hours
Unified Technical Concepts II (Physics)	3	6	9
Chemistry for Energy Technology II	3	2	5
*Technical Math II	2	0	2
Energy Production Systems	2	0	2
*Fundamentals of Electricity and Electromechanical Devices	3	4	7
	13	12	25

THIRD SEMESTER	Lec	Lab	Contact Hours
Mechanical and Fluid Systems	3	4	7
Electrical Power and Illumination Systems	2	2	4
Electronic Devices and Systems	3	3	6
*Schematic and Blueprint Reading	1	2	3
Energy Conservation	2	2	4
	11	13	24

FOURTH SEMESTER	Lec	Lab	Contact Hours
*Codes and Regulations	2	2	4
Heating, Ventilating, and Air Conditioning	3	3	6
Technical Communications	3	0	3
Instrumentation and Controls	3	3	6
Energy Economics and Audits	3	3	6
	14	11	25

*COURSES NOT DEVELOPED   SPECIFIED ONLY

MATERIALS AVAILABLE

1) ECUT Program Planning Guide – (170 pages) $12.50
Includes job/task descriptions, national data on workforce requirements, curriculum information, course outlines, and detailed program planning recommendations.

2) ECUT Instructional Modules – student text/lab materials, approximately 35 pages each (5–10 modules/course). $2.50/module

3) Unified Technical Concepts (Physics for Technicians)
13 Concept Modules, select from 170 Application (lab) Modules (Inquire for titles and cost information).

HEATING, VENTILATING, AND AIR CONDITIONING — $20.00

This course is designed to develop an understanding of air conditioning and heating systems and their characteristics, applications, and limitations. The intent of this course is to present the basics of such systems and factors affecting the selection and efficient operation of both commercial and residential heating and air conditioning equipment.

- Module HC-01 Basic Refrigeration Cycle
- Module HC-02 System Types
- Module HC-03 Refrigeration Equipment
- Module HC-04 Residential Heating Equipment
- Module HC-05 Boilers for Heating Applications
- Module HC-06 Piping
- Module HC-07 Air Handling Equipment
- Module HC-08 Psychrometrics

MICROCOMPUTER OPERATIONS — $17.50

This course covers the operation and programming of microcomputers. The first part of the course concentrates on general concepts such as computer codes, binary arithmetic and the major parts of most computers. The small microcomputer systems are studied and applied to typical energy-related data-gathering and control problems. In the third part of the course, a larger, disk-based system is used. Its operation and the kinds of software it uses are studied and applied to energy conservation. Finally, students learn the elements of BASIC programming.

- Module MO-01 Computer Codes
- Module MO-02 Microcomputer Architecture
- Module MO-03 Microcomputer Applications
- Module MO-04 Disk Based Operations
- Module MO-05 Energy Applications of Microcomputers
- Module MO-06 Introduction to BASIC
- Module MO-07 BASIC Programming

MICROCOMPUTER HARDWARE — $17.50

This course provides an introduction to hardware associated with microcomputers used in energy-conservation applications. It concentrates on interfacing and on input/output electronics. Design of microcomputers is covered only to the point of enabling students to pinpoint problems and specify systems appropriate for various applications.

The course begins with an introduction to integrated circuit logic and a discussion of common electrical and logical digital interfacing techniques. Specific techniques for getting both digital and analog data into and out of microcomputers are surveyed. Applications of these techniques to actual control problems are illustrated. Finally, data communication ideas and microcomputer troubleshooting techniques are covered.

- Module MH-01 Digital Components
- Module MH-02 Semiconductor Logic Families
- Module MH-03 Input/Output Devices and Techniques
- Module MH-04 Analog/Digital Conversion
- Module MH-05 Data Communication
- Module MH-06 Bus Systems
- Module MH-07 Troubleshooting Microcomputer Components

ELECTRONIC DEVICES AND SYSTEMS — $17.50

Electronic Devices and Systems is designed to provide the student with a working knowledge of modern electronic devices and the circuits in which they are employed. Electronic troubleshooting techniques are stressed throughout the course. Topics presented include rectifiers, transistors, SCRs and triacs, vacuum and gaseous tubes, filters, amplifier circuits, operational amplifiers, noise reduction, digital circuits, and display devices.

- Module ED-01 Concepts and Applications of Input and Output
- Module ED-02 Vacuum Tubes
- Module ED-03 Solid State Devices
- Module ED-04 Integrated Circuits
- Module ED-05 Indicators and Displays
- Module ED-06 Digital Techniques
- Module ED-07 Analog and Digital Systems

ELECTRICAL POWER AND ILLUMINATION SYSTEMS — $20.00

This course is designed to provide the student with a practical knowledge of electrical power, distribution systems, and illumination systems. In addition, the students also practice electrical measurement, wiring methods, illumination measurement, circuit control — and are provided with an overview of the parts of the electrical distribution system.

- Module PI-01 Efficiencies of Electrical Power Distribution Systems
- Module PI-02 Electrical Power Transmission and Distribution
- Module PI-03 Industrial Electrical Distribution
- Module PI-04 Residential Electrical Distribution
- Module PI-05 Electrical Energy Management
- Module PI-06 Fundamentals of Illumination
- Module PI-07 Light Sources
- Module PI-08 Efficiency in Illumination Systems

TECHNICAL COMMUNICATIONS — $20.00

The ability to write and speak well is important not only for the transfer of information, writing capabilities, as well as speaking expertise, often have an effect on the employee's advancement. This course, Technical Communications, shows the technician how to develop ideas in a clear, organized fashion. The exercises included in each module will help the student put new skills into practice.

- Module TC-01 Introducing Technical Communications
- Module TC-02 Conducting and Reporting Research
- Module TC-03 Writing Outlines and Abstracts
- Module TC-04 Writing Definitions
- Module TC-05 Describing Mechanisms
- Module TC-06 Describing a Process
- Module TC-07 Performing Oral and Visual Presentations
- Module TC-08 Preparing a Formal Report

MECHANICAL DEVICES AND SYSTEMS $20.00

Mechanical Devices and Systems is an in-depth study of the principles, concepts, and applications of various mechanisms that may be encountered in industrial application of energy use and conservation. The mechanical components and systems are divided into eight modules of instruction, covering operational procedures, uses, maintenance, troubleshooting, and repair and replacement procedures. The procedure or application portion of the modules will emphasize practical maintenance and installation of equipment and selection and specification of proper replacement components from manufacturers' catalogs.

Module MS-01	Belt Drives
Module MS-02	Chain Drives
Module MS-03	Gear Drives
Module MS-04	Drive Train Components I
Module MS-05	Drive Train Components II
Module MS-06	Linkages
Module MS-07	Fans and Blowers
Module MS-08	Valves

ELECTROMECHANICAL DEVICES $17.50

Electromechanical Devices is designed to provide the student with a working knowledge of control elements in electrical circuits, transformers, motors, and generators. Topics presented include switches, circuit breakers, relays, fuses, transformers, d.c. and a.c. motors, and generators.

Module EM-01	Electromechanical Devices — An Introduction
Module EM-02	Control Elements in Electrical Circuits
Module EM-03	Transformers
Module EM-04	Generators and Alternators
Module EM-05	D.C. Motors and Controls
Module EM-06	A.C. Motors and Controls
Module EM-07	Synchromechanisms

INSTRUMENTATION AND CONTROLS $20.00

Instrumentation and Controls is designed to provide the student with practical knowledge and skills in the specification, use, and calibration of measuring devices and the principles and applications of automatic control processes. The course stresses the integration of knowledge gained in previous courses through the detailed examination of control systems for electrical power production, heating, air conditioning, and manufacturing.

Module IC-01	Principles of Process Control
Module IC-02	Instruments for Fluid Measurements — Pressure and Level
Module IC-03	Fluid Flow Measurement
Module IC-04	Instruments for Temperature Measurement
Module IC-05	Instruments for Mechanical Measurement
Module IC-06	Pneumatic Controls
Module IC-07	Automatic Control Systems
Module IC-08	Boiler and Other Special Control Systems

FLUID POWER SYSTEMS $20.00

Fluid Power Systems is designed to give the student an overview of fluid power technology and a working knowledge of each of the components used in fluid power circuits. Hydraulic and pneumatic systems will be discussed, with emphasis placed on troubleshooting and maintenance procedures involved in each. Topics presented will include fundamentals of fluid dynamics, conventional fluid circuits, and fluid power components.

Module FL-01	Introduction and Fundamentals of Fluid Power
Module FL-02	Fluid Power Properties and Characteristics
Module FL-03	Fluid Storage, Conditioning, and Maintenance
Module FL-04	Pumps and Compressors
Module FL-05	Actuators and Fluid Motors
Module FL-06	Fluid Distribution and Control Devices
Module FL-07	Fluid Circuits
Module FL-08	Troubleshooting Fluid Circuits

CHEMISTRY FOR ENERGY TECHNOLOGY

Chemistry for Energy Technology is a course designed with a special emphasis on all aspects of chemistry as it relates to the work of an energy technician. The basic chemistry information and techniques presented in the 11 modules of this course have been deemed necessary for the applications that will be encountered by the energy technician.

BOOK I $12.50

Module CH-01	Safety in Chemical Operations
Module CH-02	Structure of Matter
Module CH-03	Chemical Equations and Calculations
Module CH-04	Refrigeration, Gases, Air Pollution
Module CH-05	Solutions

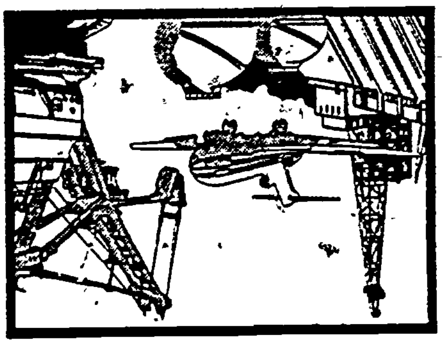
BOOK II $15.00

Module CH-06	Corrosions and Electrochemistry
Module CH-07	Metals and Ceramics
Module CH-08	Thermodynamics and Thermochemistry
Module CH-09	Fuels
Module CH-10	Plastics, Adhesives, and Lubricants
Module CH-11	Nuclear Chemistry

APPENDIX E

DIFFUSION WORKSHOP FLIER

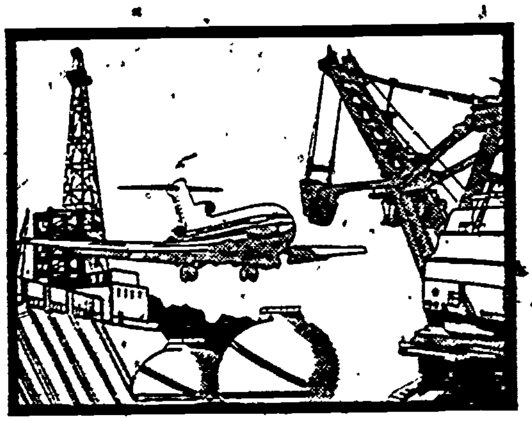
Address Correction Requested



CENTER FOR OCCUPATIONAL RESEARCH AND DEVELOPMENT
4800 Lakewood Drive
Waco, Texas 76710

Bulk Rate
U. S. Postage
PAID
Permit No: 1925
Waco, TX 76710

1981 CURRICULUM WORKSHOPS FOR...



DESCRIBING TRAINING PROGRAMS AND COURSE MATERIALS FOR SCHOOLS AND INDUSTRY

Minneapolis/May 6-7
Washington, D.C./May 19-20
Atlanta/May 27-28
Denver/June 3-4
Honolulu/June 18-19

1981 CURRICULUM WORKSHOPS FOR...

Energy Conservation and Use Technicians

79,000 Energy Technicians are needed by 1990

According to a nationwide survey of employers*, 79,000 technicians will be needed in this decade for energy-related jobs in conservation, audits, research, manufacturing, construction, building maintenance, and various areas of energy production (electrical power plants, solar equipment, process heating, etc.).

This urgent national demand can only be met by a cooperative response from schools and industry to

- Implement postsecondary programs at two-year institutions to prepare students for employment as energy technicians
- Retrain presently employed technicians through continuing education processes

Energy Conservation and Use Technicians (ECUTs)

Energy Conservation and Use Technicians are systems oriented workers who may be required to perform some combination of the following tasks:

- Energy conservation technical services for construction, retrofits, load balancing, etc.
- Provide direct support to engineers and scientists [illegible] energy and perform energy use audits
- Operate and/or maintain mechanical, electrical/electronic, electromechanical, pneumatic, and digital equipment or systems
- Provide building "operating engineer" services
- Conduct systems operational tests and analyses
- Install and monitor computer controlled equipment

The combination of knowledge, skills and abilities required for these tasks must be obtained through broad, interdisciplinary technical training. A new form of curriculum is needed to prepare technicians for these emerging occupations — a curriculum that not only deals with the complex technical aspects of modern equipment, but also provides the flexibility to include specialty courses such as solar, petroleum, geothermal, biomass, and wind, when such requirements are dictated by local needs.

Training programs and materials have been developed and tested

For the past three years, the U. S. Department of Education has sponsored the development of an ECUT curriculum and instructional materials.

Over 4,000 pages of student/instructor text materials have been developed by the Center for Occupational Research and Development (CORD). These modular, performance based materials present technical principles, problem solving situations, hands-on laboratory activities and operating procedures.

These materials have been developed and tested in schools, as an entire ECUT curriculum, as support courses in other curricula, and for adult education. ECUT graduates from the four field-test schools are highly sought by employers across the country.

*An Assessment of Employer Needs for Energy Use and Conservation Technicians, conducted by Dr. Kris Moore of the Hankamer School of Business, Baylor University.

Minneapolis/May 6-7
Ramada Inn
4200 West 78th Street
Minneapolis, Minnesota 55435
(612) 831-4200

Washington, D.C./May 19-20
Quality Inn College Park
7200 Baltimore Avenue
College Park, Maryland 20740
(301) 864-5820

Atlanta/May 27-28
Holiday Inn Airport
1380 Virginia Avenue
Atlanta, Georgia 30320
(404) 762-8411

Denver/June 3-4
Holiday Inn Airport
4040 Quebec
Denver, Colorado 80216
(303) 321-6666

Honolulu/June 18-19
Korean Studies Center
University of Hawaii, Manoa
1881 East West Road
Honolulu, Hawaii 96822
(817) 772-8756 (CORD)

Purpose of the workshops

Five regional workshops will be conducted throughout the U. S. to describe the ECUT curriculum, distribute and review the course materials, plan and discuss ways and means to implement ECUT programs, and organize cooperative relationships between schools and employers within each state. Time will be allocated for representatives from each state to meet together and initiate planning.

Agenda topics

- Rationale for broad-based energy technician
- A look at the model curriculum
- A step-by-step procedure for program implementation
- Adapting the program to meet service area needs
- Employment opportunities for energy technicians
- Working with potential employers
- Panel discussions
- Other uses for course materials
- Cost of implementing program

Who should attend?

- Local and state directors of vocational education
- Two-year postsecondary school administrators
- Instructional development personnel
- Adult/continuing education directors
- Training managers for industry
- Directors/deans of science and technology
- Industry personnel responsible for energy conservation
- Utility companies
- Research and development organizations
- Building management concerns
- Energy consulting groups

About the workshops

Each workshop will be one and one-half days in length. All participants should be registered and in the meeting room by 1 p.m. the first day. The afternoon session of the first day will last until 5 p.m. Early in the evening there will be an informal social hour and instructional materials review session. This will be an excellent time for participants to get acquainted and share ideas relative to energy education. On day two, the workshops will begin at 8:30 a.m. There will be a morning and an afternoon break, with further time for informal discussion at a luncheon, which is provided at no extra charge to registered participants. The workshops will adjourn at approximately 4 p.m. on the second day.

Sponsor

U.S. Department of Education – Office of Vocational and Adult Education – Division of National Vocational Programs – Curriculum and Instruction Branch.

Registration information

Fee for each workshop is $20 if preregistering and $30 if paid at the door. Please fill out the registration form and mail to (or call):

Center for Occupational Research and Development
4800 Lakewood Drive
Waco, Texas 76710
(817) 772-8756

Room reservations

Workshop participants are responsible for making their own hotel reservations. A block of rooms is being reserved at most workshop hotels until two (2) weeks prior to the workshop date. Please mention the workshop name when making room reservations.

REGISTRATION FORM

1981 CURRICULUM WORKSHOPS FOR...

Energy Conservation and Use Technicians

Please check appropriate box:

- ☐ MINNEAPOLIS/MAY 6-7
- ☐ WASHINGTON, D.C./MAY 19-20
- ☐ ATLANTA/MAY 27-28
- ☐ DENVER/JUNE 3-4
- ☐ HONOLULU/JUNE 18-19

Name ____________________

Title ____________________

Name ____________________

Title ____________________

Organization ____________________

Address ____________________

City ____________________

State ____________ Zip ____________

Phone ____________________

________ My check is enclosed
________ My company is forwarding check by ________
________ Registration to be covered by P.O. No. ________

Workshop coordinator

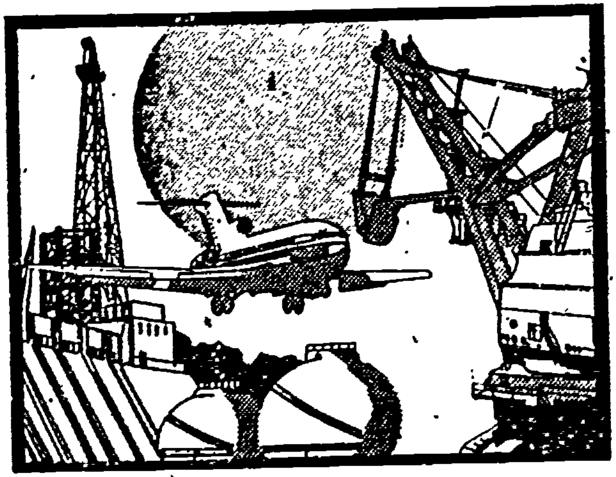
THE CENTER FOR OCCUPATIONAL RESEARCH AND DEVELOPMENT – is a nonprofit corporation that conducts research, development, evaluation, and dissemination activities in postsecondary education and training for technical occupations.

CORD (formerly TERC-SW) identifies workforce needs in new and expanding occupations and develops program plans and instructional materials to be used by two-year institutions that provide specialized training programs. CORD also assists schools and industry in implementing the programs and adapting them to meet local need.

APPENDIX F

TYPICAL DIFFUSION WORKSHOP AGENDA

ENERGY CONSERVATION-AND-USE TECHNICIANS



WORKSHOP AGENDA

May 6 and 7, 1981

Ramada Inn
4200 West 78th Street
Minneapolis, Minnesota

WEDNESDAY, MAY 6

1:00 P.M.	Welcome and Introductions Daniel M. Hull, President, Center for Occupational Research and Development
1:10	Keynote Speaker - "Training Technicians to Develop, Produce, and Conserve Energy" Susan Roscoe, Training Manager, Residential Group, Honeywell Energy Products Center
1:40	Industry Panel - Needs for Energy Technicians "Technicians for Energy Research and Development" Ulrich Bonne, Senior Research Fellow, Honeywell Corporate Research Center "Technicians for Energy Conservation" Jim Prifrel, Manager, Residential Consumer Services, Northern States Power Company "Technicians for Energy Audits" Ram Gada, President, Gada and Associates, Inc. "Technicians for Energy Use" Gordon Lundskow, Rochester Methodist Hospital
3:30	Break
3:45	The ECUT Curriculum and Instructional Materials CORD Staff
5:00	Break
5:30 to 7:30	Social Hour Review ECUT Curriculum Materials

74

THURSDAY, MAY 7

8:30 A.M.	"Planning and Implementing Instructional Programs in Emerging Technologies" James R. Johnson, Department Coordinator, North Central Technical Institute
9:00	ECUT Programs and Courses: "The ECUT Program at Marshalltown Community College" Arlan Hackbarth, Director of Continuing Education, Marshalltown Community College "The ECUT Program at Red Wing Area Vocational Technical Institute Pat Enz, Director of Red Wing Energy Education Center "Retraining Technicians for Energy Conservation and Use" C. W. DeVore, Adult Coordinator, 916 Area Vocational Technical Institute "Retraining Employed Energy Technicians" Jeanne Brownback, Coordinator of Energy Programs, Rochester Area Vocational Technical Institute
11:00	Break
11:15	Interview with an Energy Conservation-and-Use Technician Sam Knopp, Red Wing Area Vocational Technical Institute
11:40	Check out of motel room
12:00	Lunch
1:15	School/State Requirements, of CORD for Dissemination of ECUT Planning/State (Groups) CORD Staff
3:00	Break
3:15	Program Implementation Strategies Reports from States on Energy Training Activities in State Identify School Needs as Related to ECUT Curriculum Develop State ECUT Diffusion Plan
4:00	Adjourn

APPENDIX G

DIFFUSION WORKSHOP FOLLOW-UP LETTER FROM CALIFORNIA

C.O.R.D.

OCT 08 1981

RECEIVED

CHANCELLOR'S OFFICE

CALIFORNIA COMMUNITY COLLEGES

1238 S STREET
SACRAMENTO, CALIFORNIA 95814
(916) 445-8752 (916) 445-8283

October 2, 1981

Mr. Daniel M. Hull, President
Center for Occupational Research
and Development
4800 Lakewood Drive
Waco, Texas 76710

Dear Mr. Hull:

You may recall me as the representative of California from the State Chancellor's Office, California Community Colleges. The interest and impressions gained from the seminar/workshop at Denver are now bearing fruit in terms of curricular adaptation for energy related application in California community colleges. The following is the background and the development of the program we are about to implement shortly at six community colleges here in California.

Within a matter of days upon my return from the Denver workshop, I was approached by the Director of Technical Training Services of the California Association of the Sheet Metal and Air Conditioning Contractors National Association (SMACNA), as to the possibility of placing a new apprenticeship program in selected areas of California. Apparently, there is now a viable realization that there are few skilled mechanics to implement a growing move to retrofit a large part of the public building sector here, particularly the physical plant of the public school system. New private residential "starts" continue to be depressed in California as is the case elsewhere.

I reviewed the proposed national SMACNA training outline and found it totally unacceptable for state approval to the community colleges. I found its content paralleling that of what some of our energy-oriented curriculum people were having marked success at the eighth grade level.

Reviewing once again, the Energy Conservation-and-Use Technology program Planning Guide I received from you, I decided that I needn't re-invent the wheel in developing a curricular program to serve as related instruction for this proposed apprenticeship program. As the result, I telephoned an order to Jean Forcher. From the courses and modules ordered, we have outlined a one hundred sixty (160) hours of related instruction, the initial outline of which I have enclosed. This outline is the first "cut" in the organizational pattern. Some titles have been modified although I have retained the modular designations. Initially, the pattern is set for four hour training blocks, although our review considerations are still in progress.

Should you have time in your busy schedule, I would appreciate any comments you might have on our approach of curricular adaptation rather than curricular development. I do have one formal request, however, for your consideration. All through the modules, there is the caution as to reproduction of the materials. I have found instances where I would hope to make transparancies to supplement a lecture approach. I would formally ask permission to reproduce from the modular content such elements which would supplement the oral instructional presentation.

To continue, I have been given to understand that there is to be a class of eight hundred (800) apprentices starting no later than next February and possibly as early as November of this year. The six colleges participating will be:

In the South;

San Diego Mesa College, San Diego, CA
Orange Coast College, Costa Mesa, CA
Los Angeles Trade-Tech College, Los Angeles, CA

In the North;

San Mateo, College of, San Mateo, CA
American River College, Sacramento, CA
Fresno City College, Fresno, CA

The training period is projected for forty (40) weeks during one year. The 160 hours is the related instruction in conjunction to the regular formal on-the-job apprenticeship as prescribed by our California Apprenticeship Council. I am currently reviewing the academic and experience qualifications of some thirty-odd potential instructors as the basis of instruction resources. As you may note, I have already proposed use of some 90 odd modules. I now wonder if this proposal can be met? What would be the pricing of unbound modules in a quantity of 30 odd? What lead time would you need from time of telephone order to shipment from Waco? There may be other questions which you can foresee, and I would appreciate your counsel.

Sincerely,

John P. Picco

John P. Picco, Ed.D.
Curricular Program Coordinator

JPP:pb

Enclosure

1. A. Introduction to Energy Technology/Conservation

   EF-01 EF-02

   B. Introduction to Energy Conservation

   EC-01

   C. Technical Computation -- Formula Interpretation

   S-1

2. A. Sources of Energy

   EF-03

   B. Concepts of Physics -- Force

   CM 1-0

   C. Energy Systems -- Space Heating

   EC-02 Lab - Space Heating Demonstration

3. A. Energy Uses

   EF-04

   B. Energy Load Identification

   (Develop from Energy Audit, etc.)

   C. Energy Analysis

   EF-05

   D. Concepts of Physics -- Work

   CM 2-0

4. A. Energy and the Environment

   EF-06

   B. Energy Systems -- Space Cooling

   EC-3 Lab - Space Cooling Demonstration

   C. Technical Computation -- Dimensioning in Energy

   S-2

5. A. Energy Systems -- Hot Water and Steam

   EC-04 Lab - Boiler Demonstration

   B. Technical Computation -- International Unit System

   S-3

   C. Concepts of Physics -- Rate

   CM 3-0

6. A. Energy Systems -- Illumination

   EC-05 Lab - Illumination Demonstration

   B. Technical Computation -- Angles and Triangles

   S-4

   C. Safety for the Technician -- Shop/On the Job

   CH-01

7. A. Energy Systems -- Electric Motors

   EC-06

   B. Technical Computation -- Graphs

   C. Concepts of Physics -- Momentum

   CM 4-0

8. A. Energy Systems -- Building Construction

   EC-07

   B. Building Site - Envelope - Interiors

   (Develop from Title 24 materials)

   C. Concepts of Physics -- Resistance

   CM 5-0

9. A. Energy Production Systems -- Combusion and Heat Transfer

(1) Solid Fuels

EP-01

(2) Liquid and Gaseous Fuels

EP-02

B. Technical Computation -- Precision Measurement

S-8

C. Concepts of Physics -- Power

CM 6-0

10. A. Energy Production Systems -- Generation of Steam and Hot Water

(1) Solar

EP-03

(2) Nuclear and Experimental Power Sources

EP-04

B. Building Utilization and Operation

(Develop from Title 24 materials)

C. Concepts of Physics -- Potential on Kinetic Energy

CM 7-0

11. A. Energy Production Systems

(1) Combustion Engines

EP-05

(2) Turbines

EP-06

B. Fundamentals of Energy Cost Analysis

EE-01

C. Concepts of Physics -- Mechanical Advantage

CM 8-0

12. A. Electro Mechanical Devices — Fundamentals

EM-01 FE-01

B. Electrical Control Elements

EM-02 FE-02 FE-05 FE-06

C. Lab — Magnetic Demonstrations — Electric Circuits

D. Concepts of Physics — Energy Conversion

13. A. Electromechanical Devices

(1) Transformers

EM-03

(2) Generators and Alternators

EM-04

B. Lab — Demonstrations

C. Economics of Energy Alternatives

EE-04

D. Concepts of Physics — Transducers

CM 10-0

14. A. Electromechanical Devices

(1) D. C. Motors and Controls

EM-05 FE-03

(2) A. C. Motors and Controls

EM-06 FE-04

B. Laboratory Demonstrations

C. Concepts of Physics — Time Constants

CM 12-0

15. A. Synchromechanisms

EM-07

Laboratory Demonstrations

B. Energy Analysis -- Life Cycle Costing Concept

EE-05

(Federal publication)

C. Technical Communication -- Fundamentals

TC-01 & (TC-02 optional)

16. A. Energy Production Systems

(1) Electricity

EP-07

B. Technical Communication -- Outlines and Abstracts

TC-03

C. Characteristics of Electrical Power Systems

PI-01

17. A. Electrical Power Transmission and Distribution

PI-02

B. Technical Communication -- Writing Definitions

TC-04

C. Fundmanentals of Fluid Power

FL-01

18. A. Industrial Electrical Distribution

PI-03

B. Technical Communication -- Mechanism Description

TC-05

18. C. Properties and Characteristics of Fluid Power

FL-02

19. A. Residential Electrical Distribution

PI-04

B. Technical Communication -- Process Description

TC-06

C. Fluid Storage -- Conditioning -- Maintenance

FL-03

20. A. Electrical Energy Management

PI-05

B. Technical Communication -- Application

TC-07 & TC-08 (Instructor option)

C. Pumps and Compressors

FL-04

D. Laboratory Demonstration/Exercises

21. A. Fluid Distribution and Control Devices

FL-06

B. Fundamentals of Illumination

PI-06

C. Laboratory Demonstrations/Exercises

22. A. Fluid Circuits

    FL-07

    B. Light Sources

    PI-07

    C. Laboratory Demonstrations/Exercises

23. A. Troubleshooting Fluid Circuits

    FL-08

    B. Illumination System Efficiency

    PI-08

    C. Laboratory Demonstrations/Exercises

24. A. HVAC - Basic Refrigeration Cycle

    HC-01

    B. Gas Laws and Air Pollution Considerations

    CH-04

    C. Laboratory Demonstrations/Exercises

25. A. HVAC - Refrigeration Equipment

    HC-03

    B. Mechanical Systems - Belt Drives

    MS-01

    C. Laboratory Demonstrations/Exercises

26. A. HVAC - System Configuation

HC-02

B. Mechanical Systems - Chain Drives

MS-02

C. Laboratory Demonstrations/Exercises

27. A. HVAC - Residential Heating Equipment

HC-04

B. Mechanical Systems - Gear Drives

MS-03

C. Laboratory Demonstrations/Exercises

28. A. HVAC - Boilers for Heating Applications

HC-05

B. Mechanical Systems - Drive Train Components I

MS-04

C. Laboratory Demonstrations/Exercises

29. A. HVAC - Piping

HC-06

B. Mechanical Systems - Drive Train Components II/Linkages

MS-05 MS-06

C. Laboratory Demonstrations/Exercises

30. A. HVAC - Air Handling Equipment

HC-07

B. Mechanical Systems - Trans and Blowers

MS-07

C. Laboratory Demonstrations/Exercises

31. A. HVAC - Psychrometrics

HC-08

B. Mechanical Systems - Valves

MS-08

C. Laboratory Demonstrations/Exercises

32. A. Energy Audits - Total Energy Management

EA-01

B. Control Process

IC-01

C. Laboratory Demonstrations/Exercises

33. A. Energy Audits - Procedures and Analyses

EA-02

B. Energy Audits - Audit Elements

EA-03

C. Instruments for Fluid Measurement - Pressure and Level

IC-02

34. A. Energy Audits - Building Systems

EA-04

B. Fluid Flow Measurement

IC-03

C. Laboratory Demonstrations/Exercises

35. A. Energy Audits - Lighting Systems

EA-05

B. Temperature Measurement

IC-04

C. Laboratory Demonstrations/Exercises

36. A. Energy Audits - HVAC I

EA-06

B. Mechanical Measurement

IC-05

C. Laboratory Demonstrations/Exercises

37. A. Energy Audits - HVAC II

EA-07

B. Pneumatic Controls

IC-06

C. Laboratory Demonstrations/Exercises

38. A. Energy Audits - Auxiliary Equipment Systems

EA-08

B. Boiler and Special Controls

IC-08

C. Laboratory Demonstrations/Exercises

39. A. Energy Audits - Process Energy Systems

EA-09

B. Automatic Controls

IC-07

C. Laboratory Demonstrations/Exercises

40. A. Energy Audits - Solar Energy

EA-10

B.

C. Laboratory Demonstrations/Exercises

APPENDIX H

UTC WORKSHOP FOLLOW-UP LETTER FROM IDAHO

COLLEGE of SOUTHERN IDAHO
Junior College District
P.O. Box 1238
TWIN FALLS, IDAHO 83301

DEC 03 1981
RECEIVED

November 24, 1981

Mr. Dan Hull
C.O.R.D.
601 Lake Air Drive
Suite C
Waco, TX 76710

Dear Dan:

Enclosed is a purchase order for the amount of your invoice dated 11-12-81. I am sending an additional $255.00 to pay for another set of U.T.C. Application Modules. Please send the additional set as soon as possible.

We have decided to include U.T.C. in our curriculum for energy technicians, as a series of two four-semester-hour courses. We are also considering utilizing most of the E.C.U.T. program in our Energy Management specialization. Would you please send me a complete set of the E.C.U.T. program on approval.

Hope to hear from you as soon as possible. Thank you for all the help.

Sincerely,

Dave Makings

Dave Makings, Coordinator
Energy Technician

DM/rb

Enclosure