

**THE IMPORTANCE OF SELECTED ENERGY TECHNOLOGY PROGRAM
GOALS, AS PERCEIVED BY NATIONALLY SELECTED ENERGY
TECHNOLOGY TEACHER EDUCATORS**

by

Brian Martin Crandell

**A professional paper submitted in partial fulfillment
of the requirements for the degree**

of

Master of Science

in

Industrial Arts Education

**MONTANA STATE UNIVERSITY
Bozeman, Montana**

June 1984

P378
C85
cop. 2

APPROVAL

of a professional paper submitted by

Brian Martin Crandell

This professional paper has been read by each member of the paper committee and has been found to be satisfactory regarding content, English usage, format, citation, bibliographic style, and consistency, and is ready for submission to the College of Graduate Studies.

6/7/84
Date

Dorey Polette
Chairperson, Graduate Committee

Approved for the Major Department

6/8/84
Date

Mal S. Anderson
Head, Major Department

Approved for the College of Graduate Studies

6-14-84
Date

MB Malne
Graduate Dean

STATEMENT OF PERMISSION TO USE

In presenting this paper in partial fulfillment of the requirements for a master's degree at Montana State University, I agree that the Library shall make it available to borrowers under rules of the Library. Brief quotations from this paper are allowable without special permission, provided that accurate acknowledgment of source is made.

Permission for extensive quotation from or reproduction of this paper may be granted by my major professor, or in his absence, by the Dean of Libraries when, in the opinion of either, the proposed use of the material is for scholarly purposes. Any copying or use of the material in this paper for financial gain shall not be allowed without my permission.

Signature Brian Connell

Date June 11, 1984

ACKNOWLEDGMENTS

The writer wishes to express his sincere appreciation to those persons visited with during his stay in Bozeman. Further appreciation is to be accorded to the members of the writer's graduate committee: Grace France, Jere Wheatley and Doug Polette.

TABLE OF CONTENTS

	Page
APPROVAL	ii
STATEMENT OF PERMISSION TO USE.....	iii
VITA.....	iv
ACKNOWLEDGMENTS.....	v
TABLE OF CONTENTS.....	vi
LIST OF TABLES.....	viii
ABSTRACT	x
Chapter	
1 INTRODUCTION.....	1
Statement of the Problem.....	2
Need for the Study	2
Specific Objectives	3
Significance of Study	3
Basic Assumptions of the Study	4
Delimitations of the Study	4
Definition of Terms.....	5
2 REVIEW OF THE LITERATURE	6
Historical and Economic Development of Energy Technology	6
Current and Future Implications of Energy Technology.....	9
A Rationale for Energy Technology as Part of General Education	11
Energy Technology Subject Areas to be Taught as Part of General Education	12
The Role of Industrial Arts in Energy Technology Education.....	13
Summary.....	15
3 PROCEDURE.....	16
Procedure of Panel Selection.....	18
Development of Instrument	19

TABLE OF CONTENTS—Continued

	Page
4 PRESENTATION AND INTERPRETATION OF DATA	21
5 SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS.....	44
Summary.....	44
Conclusions.....	46
Recommendations.....	46
BIBLIOGRAPHY	48
APPENDICES.....	51
APPENDIX A – Questionnaire Respondents	52
APPENDIX B – Comparison of Winek Study Goal Rank to Crandel Study Goal Rank.....	59
APPENDIX C – Comparison Table.....	62
APPENDIX D – Letter to Department Administrators.....	65
APPENDIX E – First Round Questionnaire and Cover Letter	67
APPENDIX F – Second Round Questionnaire and Cover Letter	71

LIST OF TABLES

Tables	Page
1. Presentation and Interpretation of Data	21
2. Institutional Participation Breakdown.	22
3. GOAL 1. Six Forms of Energy	22
4. GOAL 2. Basic Energy Laws	23
5. GOAL 3. Energy Application.	23
6. GOAL 4. Background on Current Energy Problems	24
7. GOAL 5. Factors of United States Dependence on Energy	24
8. GOAL 6. United States Energy Supply and Demand	25
9. GOAL 7. United States Activities for Energy Independent Nation.	25
10. GOAL 8. International Energy Supply and Demand	26
11. GOAL 9. International Scope of Energy Problem	26
12. GOAL 10. Various Sources of Energy	27
13. GOAL 11. Advantages and Disadvantages of Energy Sources.	27
14. GOAL 12. Various Means of Obtaining Energy	28
15. GOAL 13. Various Methods of Energy Transmission	28
16. GOAL 14. How Energy is Stored	29
17. GOAL 15. Fossil Fuel Energy Applications	29
18. GOAL 16. Nonfossil Fuel Energy Applications	30
19. GOAL 17. Energy Conservation Methods of Building Construction	30
20. GOAL 18. Energy Conservation Methods in Existing Dwellings.	31
21. GOAL 19. Energy Conservation Methods in Industry	31

Tables	Page
22. GOAL 20. Energy Conservation Methods in Transportation	32
23. GOAL 21. Experiences and Activities for Prudent Energy Utilization.....	32
24. GOAL 22. Basic Concepts of Energy Conversion	33
25. GOAL 23. Information on Present Energy Conversion Devices	33
26. GOAL 24. Information on Future Energy Conversion Devices.	34
27. GOAL 25. Alternate Energy Sources	34
28. GOAL 26. Environmental Impacts of Alternative Energy Sources	35
29. GOAL 27. Implications of Various Alternative Energy Sources.....	35
30. GOAL 28. Impact on Lifestyles from Different Energy Options	36
31. GOAL 29. Ethical Issues in the Use of Energy	36
32. GOAL 30. Political Implications of Developing New Energy Resources	37
33. GOAL 31. Social Implications of Developing New Energy Resources	37
34. GOAL 32. Economic Implications of Developing New Energy Resources	38
35. GOAL 33. Develop Ability to Solve Energy Problems	38
36. GOAL 34. Interrelationship Between Technology and Society in the Solution of Energy Problems.	39
37. GOAL 35. Ability to Research Energy Use in a Technological Society	39
38. GOAL 36. Understanding of Available Consumer Energy Options.....	40
39. GOAL 37. Understanding of Energy Options Available to Society as a Whole	40
40. Rank of Major Area Headings by Mean Score of Component Goals' Means.....	41
41. Rank of Combined Respondent Mean Scores (X) for Each Goal From Round 2	42

ABSTRACT

The purpose of this study was to determine the degree of importance of selected energy technology education program goals according to nationally selected energy technology teacher educators. This study was conducted because there did not exist a set of energy technology education program goals that had received national comment.

The Delphi technique was used to examine energy technology education program goals from the Winek Energy Education Program study of 1981. The panel consisted of one hundred one energy technology teacher educators serving as staff of institutions listed in the Industrial Teacher Education Directory, 21st ed. Two questionnaire rounds were employed in this study. Data compiled from the second round indicates the mean perceived level of importance of the energy technology education program goals by nationally selected energy technology teacher educators.

The major conclusions indicated by this study showed that individual panel members involved in and/or having knowledge of energy technology education maintained a high level of interest in energy technology education. The high level of interest is evidenced by the high level of participation by panel members in both rounds. Further conclusions showed that the overall level of importance of the energy technology education program goals presented was high. Of the major area headings the goals were divided into, alternative energy sources was perceived as most important and implications for energy decisions was perceived as least important.

CHAPTER 1

INTRODUCTION

For more than three decades the role of industrial arts in general education has been considered and reconsidered. The program orientation of industrial arts in the public schools has covered a range from avocational to vocational to technological literacy.

It is the purpose of education to prepare young people to enter society as productive participants (Bender, 1982, 57). Industrial arts, in terms of course content over the past 20 years, has, at best, prepared its students to enter our industrial society. As recently as 1978, industrial arts teachers have placed the greatest emphasis of their program on the development in each student of some measure of skill in the proper use of common tools and machines (Dugger, 1980). This emphasis on manual skills with tools and machines may have been appropriate in an industrial society, but today educators face the challenge of technology shaping society (Benson, 1981, 34-35).

In order to fulfill the challenge of preparing young people for participation in a technological society, industrial arts must address the challenges of living in such a society. Most critical of these challenges is the participant's ability to direct and adapt to a dynamic society (Bender, 1982, 57). In a dynamic society education content dealing with a process orientation, rather than specific technical information, will provide valuable life coping skills (Combs, 1981, 369-372).

To contribute to the viable education of today's youth, industrial arts should provide programs leading to technological literacy. Through making students socially and technically aware of technology, they will come to understand what technology is, how it affects

them as individuals and members of groups, and how they can direct and utilize technology appropriately (Jenks, 1980, 4).

The industrial arts program addressing technological literacy would center around three areas: production, communication, and transportation. A major second order study area, mutually inclusive in each of the three areas would be the study of energy technology. Learning experiences in energy technology would involve individual, group and interdisciplinary participation, experimentation, decision making and problem solving. Activities related to the study of energy technology would include psychomotor and cognitive skills reflecting science, society and technology (Gilberti, 1980, 4).

In conclusion, Steels (1976) states the following in Schwaller's book, *Energy Technology: Sources of Power*:

The attitude and practices of the public must be aligned with the realistic data and world resource situation. Education stands foremost as the prime motivator of energy literacy.

Statement of the Problem

The purpose of this study was to determine the degree of importance of selected energy technology education program goals according to nationally selected energy technology teacher educators.

Need for the Study

Industrial arts can make a significant contribution to the technological literacy of the students. In order to make that contribution, industrial arts must address relevant topics with relevant information. The area of energy technology has a considerable effect in our lives, specifically; economic, environmental, political, and social impacts.

If our students are to gain technological literacy to direct and cope with these changes they must be prepared to deal with information from the entire energy picture. Students

should be competent in basic understandings of energy resources, processing, distribution, and utilization, as well as in the socio-cultural implications of energy technology. With these competencies students will add to their technological literacy. Piel and Truxal (1981, 139) stated this position well:

Technology can present to the public and its political process a picture of the options—a model of the problem which includes the advantages and disadvantages of each alternative.

The ultimate goal of technological literacy is better decisions.

With industrial arts in Montana making a significant contribution to the students' technological literacy in general and energy technology literacy specifically, many people will benefit. First, students, as they will gain relevant decision-making abilities (Gilberti, 1983, 13). Second, society, as it will perceive these students as decision makers. And third, educators and their programs, as relevant, responsive curricula is a sound base for future funding as money becomes a more scarce resource.

Specific Objectives

The following objectives were set for this study:

1. To assess the importance of selected energy technology education program goals as perceived by nationally selected energy technology teacher educators.
2. To identify those industrial teacher education personnel who are involved with and/or have knowledge of energy technology education.

Significance of Study

It was intended that results from this study would provide for the industrial arts profession several bases of information. Included in these bases were the following:

1. A set of energy technology education goals which would enable teachers and administrators to develop relevant curricula.

2. A basis for energy technology education planning and implementation.
3. A national list of individuals involved with and having knowledge of energy technology education.
4. Guidelines to teacher education programs for planning preservice and inservice courses.

Basic Assumptions of the Study

The following assumptions were made for this study:

1. The selected energy technology teacher educators were sufficiently well informed on the concept of energy technology education, or a component part, to enable them to realistically rate the importance of the stated energy technology education program goals.
2. The selected energy technology teacher educators were accurate in their assessment of the importance of the energy technology education program goals they reviewed.

Delimitations of the Study

This study possessed the following delimitations:

1. The questionnaire for this study could not feasibly contain all possible energy technology education program goals and was, therefore, comprised of energy technology education program goals commonly found in current literature.
2. This study sought to identify the perceived importance of selected energy technology education program goals by selected energy technology teacher educators and did not gather data regarding the implementation of such goals.

Definition of Terms

For purposes of this study the following terms will be interpreted as stated below.

Energy Technology Education—Education about the sources, applications, and implications of energy in a technological society with emphasis on socio-cultural, as well as technical context.

Energy Technology Teacher Educators—Those individuals identified by their department administrator as informed about and involved with energy technology education at an Industrial Teacher Education institution listed in the Industrial Teacher Education Directory, 1982-83 edition (E. Dennis).

Futuring—Projecting systems into the future and speculating about implications within interrelated systems.

Technology—The utilization of acquired knowledge, science, tools, materials, and processes which humans employ to control their evolutionary process (in nature and in the human-made environment), and solve the problems related to society (Gilberti, 1983, 15).

Technological Literacy—An understanding of technical context used, the interrelationships among science, politics, sociology, mathematics, and language and the application of that understanding to problem solving in societal systems.

CHAPTER 2

REVIEW OF THE LITERATURE

The following review of literature deals with (1) historical and economic development of energy technology, (2) current and future implications of energy technology, (3) a rationale for energy technology as part of general education, and (4) the role of industrial arts in energy technology education.

Historical and Economic Development of Energy Technology

Many people believe that the energy crisis began with the Arab oil embargo of 1973. Although the availability of imported oil was drastically reduced in 1973, the rate of growth that put American energy consumption at its 1973 level began to rise dramatically in the 1940s. In 1947 the United States changed from a net oil exporter to a net oil importer. In 1950 oil became the United States' main energy source. With the abundance of an inexpensive convenient oil, the American lifestyle changed. As with any abundant resource, the effects of inexpensive energy became a part of the American life style taken for granted.

As the energy rich, extravagant life style grew, the annual rate of increase of imported oil rose. Between 1970 and 1980, despite the 1973 embargo, the average annual rate of increase for American energy consumption was slightly more than 7%. By using what Piel and Truxal (1981, 37) call the doubling rule: "The number of years to double is about 72 divided by the percent of growth per year." One could figure that in 1980 Americans consumed twice the imported oil they did in 1970 (Weaver, 1981, 17). In 1970 imported oil

supplied 7.4% of the total energy consumed by Americans. In 1980 imported oil made up 15.2% of the total energy consumed by Americans. During the same time period the price of middle eastern crude oil rose from \$3 a barrel in 1970 to \$32 a barrel in 1980.

The economic impact of the rise in imported oil price has been considerable. In 1970 the United States paid out \$3 billion for imported oil. In 1980 the United States paid out over \$88 billion (Duncan, 1980, Rice Union). Weaver (1981, 16) summarized the economic input:

This hemorrhage of money has played a significant part in the weakening of the American dollar in international exchange and in stimulating inflation at home. Recession and unemployment have been aggravated. And not the least of the repercussions is the haunting fear that action to protect our foreign supply of petroleum will lead to a major war.

In every way we are paying an extravagant price for our energy rich way of life.

To further compound an energy rich lifestyle's confrontation with rising energy costs, United States oil production peaked in 1970. Every year but one since 1967 the American people had consumed more oil from proven reserves than has been found to replenish supply from new reserves (Weaver, 1981, 5).

The economic impact of the changing energy resource picture to the 1970s was concurrent with numerous other effects. Because of the increasing role of the automobile in the American lifestyle, fueled by inexpensive abundant oil, Americans became concerned about the environmental impacts of auto emissions. As early as 1963, American auto makers began employing devices to reduce atmospheric emissions of the internal combustion engines that powered the auto. This concern for the environment was not without its costs. As auto makers attempted to clean up the emissions of their products, manufacturing costs rose and as a result of decreasing emissions, fuel economy also suffered. As the price of oil began to rise in the early 1970s, Americans began to purchase smaller, more fuel efficient cars. In many cases these smaller cars were imported from Japan and Europe. This shift of market share for what was once an American domesticated field to a field of

both domestic and imported supplies of automobiles had a tremendous economic effect on the auto industry and its entire supply chain.

In 1973 Americans came face to face with the diametrically opposed coexistence of a society's lifestyle based on previous energy abundance and the sudden limitation of energy resources. The societal implications of limited resources limiting lifestyles caught many Americans off balance. Those families living great distances from places of employment or schooling found lifestyle priorities rearranged. The question was no longer which distant city should be visited on the next shopping day, but where to find enough fuel to get the wage earners to their jobs. The same case families were affected by the economic implications of losing their main source of income because of employment disruptions caused by energy related work stoppages.

Because the change of energy resource supply had so many implications throughout society, the American political system was also affected. There was energy related legislation enacted at the federal level as early as 1975 and in 1977 the United States Department of Energy was established. Through these actions the governmental process attempted to involve the public, science, and technology in the search for answers to the energy situation.

America's six percent of world population account for fifty percent of the world's natural gas consumption as well as thirty percent of the world's oil use (Piel and Truxal, 1981, 189).

Piel and Truxal (1981, 189) summarized the history and development of the energy crisis as follows:

The crisis arises because the U.S. social system has developed on the basis of a particular pattern of energy use . . . Any significant change in the cost of one type of energy in one location results in enormous disruption of the social system. The threat of such a disruption is the cause of the energy crisis.

Current and Future Implications of Energy Technology

The areas of concern regarding energy technology involve demand, supply, and future impacts. The history of energy has shown that its impact is diverse in society. Because the past and current American sociocultural lifestyle has developed an abundant, inexpensive energy technology, the advent of change in the energy resource supply will have resultant impact on the future lifestyle. The view of the energy technology future is, by its diversity, not simple. There are many different views on the energy technology future proposed by various groups. Through the variety of projections of the future, several commonalities began to develop.

The first, diversity of energy sources will increase along with consumption. Energy consumption for the year 2000 is projected to be greater than 100 quads. This compares to 78 quads in 1980. Although natural gas and imported oil will make up less of the energy source, coal, nuclear, and alternative energy sources will increase their share. Domestic oil production is expected to contribute a fairly constant share of the supply (Weaver, 1981, 17).

Since 1975 there have been numerous ideas and proposals for ways of coping with the change in energy sources. The current administration has suggested supplying 70% of the American energy demand in the year 2000 with what are now considered alternative energy sources such as solar, wind, etc. It is clear that no new immediate, large scale energy source is on the horizon to salvage the lifestyle of the 60s and early 70s. We must look to conservation, alternative and moderation of our lifestyles.

With each proposed energy source comes many implications. These implications are from not only the technical development areas, but of a socio-cultural nature as well. For example, the environmental implications of burning coal to produce electricity has resulted in an international controversy regarding acid rain (Canby, Feb. 1981, 86). Weaver (1981,

19) states this position as follows: "Virtually every proposal for adding to our energy supply involves hidden costs, unpleasant side effects, and uncertainties." Many of the new forms of alternatives are still in the research stage and are, as yet, untried in commercial application.

When dealing with a major, forced, change in energy supply and, therefore, lifestyle, the lack of specific decision making precedent is evident. In the past, the changing of energy sources and related technology were brought about as a result of striving to improve the quality of life and/or as a function of cost. Because the nature of past changes has been beneficial, that change and its implications have been incorporated into the lifestyle. With the current change, the attempt is being made to develop long turn planning for solutions that will lead to a sustainable future. This effort has involved considering a wide range of implications.

Joseph M. Dukert (Man, Society, and Technology, February 1981, 4) summarized the current trend in these words:

Much of what has been written since 1974 about America's energy future takes too narrow an outlook. Some projections are based almost entirely on technological capacity, as if to suggest anything worthwhile that can be done by applying national resources will be done. Some energy futurists, on the other hand, concentrate only on economic analysis, implying dollars-and-cents logic inevitably will guide human behavior. Still other types of energy facets can be categorized as "wishful thinking" on the part of individuals and groups responsible for them. It is easy for anyone to live up to an impressive array of arguments about why developments one fears will take place or why trends that one dislikes must peter out.

Ideally, all of the major technological, economic, philosophical, and political prospects should be considered in trying to look ahead to the end of the current energy exports.

The nature of the current and future energy source change has been termed a crisis. The projected energy source areas for the year 2000 show that there will be no simple dogmatic solution to this crisis. While development and trial of alternative energy sources will

continue, there will be no immediate, rapid remedy. As a result, conservation and improved energy efficiency will help buy time to allow for continued development.

A Rationale for Energy Technology as Part of General Education

There is little doubt that technological innovation and implementation lead to societal change. With the advent of the plow came reliable, sustainable agriculture, and as a result world population grew. With space travel has come improved communication systems and more knowledge has been unlocked about the makeup of planet Earth.

Thomas (1979, ix) addressed the relationship between technology and change as follows:

The transformation of human society by science is probably only at its beginning, and nobody can guess at how it will all turn out. At the moment, the most obvious and visible effects on our life are those resulting from the technology that derives from science, for better or for worse . . .

The scope of societal change as a result of technological advancement touches many facets of our lives. Some facets include economic, political, environmental, and cultural.

With the change in our society so rapid and widespread, the importance of understanding the change becomes evident. Not only must we come to grips with the technical nature of change, but the social/cultural implications as well. This focus on technical context and the interrelationships among science, politics, sociology, mathematics, and language has been called technological literacy (McCrary, 1980, 6).

It is with technological literacy that our students will be better prepared to direct and cope with the implications of technological change. Because technology touches all disciplines, it is important that each discipline address implications of technology unique to that area. In addition to each discipline incorporating the study of technology, it is important for students to have an opportunity to draw together and apply this information as part of their general education. Such an opportunity can be a curricula with technology as

the area of study. Courses would be future oriented and activity based with an emphasis on the relationships between the technological sector and society. Learning activities would center around problem solving and inquiry. This curricula could be called technology education (Jenks, 1980, 4).

With the technology education curriculum would be three major areas. Benson (1981, 34) summarized these areas as follows:

1. Production Technology
2. Communication Technology
3. Transportation Technology

If we, as a country, are to provide a sustainable future, knowledge of energy technology will be important as it affects our lives in so many ways. Daiber (1980, 3) addressed this point stating: "It is common knowledge that energy is necessary for the production of goods and services, communication networks, and transportation systems."

The breadth of relationship that energy has in our lives builds economic, environmental, political, and social impacts. With energy technology literacy as part of general education, our students will not only be more technically knowledgeable, but be able to apply that knowledge to current and future societal situations.

Energy Technology Subject Areas to be Taught as Part of General Education

The decision of what Energy Technology subject areas to teach is a difficult one. In remaining consistent with the overall goals of technology education, the subject content of energy technology should provide technical understanding with information about how the field of energy affects society.

Industrial arts has traditionally had the tools, materials, and facilities for activity centered learning. Activity centered learning, with an emphasis on problem solving and inquiry, could provide an excellent educational situation in an industrial arts lab setting.

Currently, there is a considerable amount of thought given to what should be taught to represent technological literacy in energy technology education. Central to energy literacy is the consideration of both technical information and the societal impact of energy (Klein, 1980, 11).

Ideally, energy technology would be taught as part of a student's general education. This is not to say that years of study would be mandated, but that an awareness and understanding of energy would be developed. To facilitate this development, many fragmented efforts in specific energy topics have yielded a variety of energy technology activators. Because energy technology education is interdisciplinary, resources can be gathered from a wide variety of sources. These resources should go beyond trivial busy work and deal with analysis, synthesis and evaluation of energy information in the context of communication, production and transportation systems. As a result, energy technology education will include activities of the mind as well as more traditional hands-on activities. Perhaps most exciting is the inclusion of interdisciplinary exercises, involving group problem solving requiring technical understanding and social awareness (Schwaller, 1980, 10).

The Role of Industrial Arts in Energy Technology Education

The role of industrial arts in Energy Technology Education can be that of coordination. Because industrial arts has traditionally been an activity centered curricula, the tools, materials, and work environment needed for energy technology education already exists. By adding sociocultural information to a technical activity centered course, we will have a learning situation that will be able to deal with full process analysis of selected energy topics. If the discussion for the day is centered around solar energy, students would not only have an opportunity for group tutoring of the socio-technical implications of solar energy, but explore first-hand some of the principles of solar applications. While involved with the actual construction of a model solar collector, the students will employ math

skills when figuring sun angles, physics skills when figuring collector surface absorbance and group process skills while participating in the group activity.

As the energy technology education coordinator, industrial arts can provide valuable resource material to other discipline areas. When biology students are studying bio mass, the class could be supplied with activities to experiment with bio gas generation on a small scale. The idea of units of instruction being designed to enhance the learning process of other classes applies within industrial arts as well. When students in materials class are studying production systems, information about where the energy used in the process comes from, and the efficiency of its use, would add greatly to a student's broad understanding of the production system. Students in the construction classes could use up-to-date energy efficient, building materials and design concepts to design low energy consuming homes of the future.

The possibilities for use of energy technology education information in a student's general education are vast. Because industrial arts has the basic tools and materials for technical skills, the addition of sociocultural information would cost little. In addition, because of the number of micro energy source experiments is fairly large, particular activities to fit a small, sparsely funded program are available. In advanced study, industrial arts students could become model decision makers and problem solvers. Students would follow the development of a particular energy resource from ideation and analysis of cost effectiveness to completion of an on-line model. The diversity and depth of this type of study clearly develops technological literacy (Gilberti, 1983, 16).

With its unique offerings of facilities, expertise and exposure to the socio-technical systems of society, industrial arts can represent the cutting edge of energy technology education as a part of the student's general education.

Summary

The literature suggests that the development of energy technology has been influenced by many factors. In addition to technological advances, energy technology has been affected by sociocultural forces such as politics, economics, environmental concerns, and lifestyles. Implications of energy technology are likely to remain similar in context, but increase in relevance as the nature of supply resources changes over the next 20 years.

The past effects and future implications of energy technology are geared to the many sectors of technology, society, and the lives of the population. Because the societal effects of energy technology are so diverse, the study of energy technology could be part of the general education of society. Industrial arts can provide a general education of society. Industrial arts can provide a general and interdisciplinary study of energy technology in an attempt to clarify what knowledge of energy education is to be considered general, an assessment of energy technology education program goals should be developed.

CHAPTER 3

PROCEDURE

When educators are attempting a change in program direction or some innovation within a given program, they face the challenge of gathering qualified, relevant input. With reliable information, a sound foundation is formed on which to base a decision regarding program development. Some areas being studied in preparation for program development have a variety of previously generated resource material available. On occasion an investigator may face the task of program development in an area in which there has been little research conducted. In such an instance, information sources are limited to those individuals with knowledge of or involvement in the area of study.

In order to provide a program direction relatively free of individual bias, it is desirable to consult a group of knowledgeable and involved individuals. Should the members of the group come up with a shared opinion, that opinion would have strength beyond the opinion of an individual member.

Reaching consensus with a large, geographically diverse group can be difficult, because it is important to consider and reconsider one's individual opinion after receiving feedback from other group members.

With a large group, individual meetings between group members and the researcher to provide feedback and allow for reconsideration of the group member's original opinion would prove time consuming and inefficient.

The Delphi Technique is a method of developing and improving group consensus. Participants are either informed or involved regarding the topic. This technique attempts to

overcome the problems associated with single expert input and logistical problems such as time and distance. The Delphi Technique is represented by Adelson as follows:

The Delphi Technique is a method for the systematic collation of expert or informed opinions. Instead of using the traditional approach toward achieving a consensus through open discussion, this technique replaced direct debate by a carefully designed program of sequential individual interrogations (test conducted by questionnaire) interspersed with feedback of the information and opinion derived, including computed consensus from the earlier parts of the program. Its intent is to treat systematically, efficiently and in depth, information contained in individual judgements, and to put that information into useful form (1967, 29).

Holstoop further addresses the Delphi Technique as follows:

It also provides a means for assessing "what is" (organizational condition) and "what shall be" (goals and objectives) (1973, 76).

Delphi applications are:

1. Accumulation of current or historical data not readily known or available.
2. Planning for curriculum development.
3. Establishment of goals and objectives.
4. Assembling of a model for instructional purposes (Linstone and Turoff, 1975, 4).

The general Delphi procedure as described is as follows:

1. Respondents who usually remain anonymous to one another are asked to list their opinions on a specific topic, such as recommended activities or predictions for the future.

The information is returned to the investigators who organize it into a listing.

2. Respondents are then asked to evaluate the total listing against some criterion, such as importance or chance of success. Information is again returned to the investigator who calculates a group mean for each item.

3. Each respondent then receives the refined list and a summary of responses to the items. If in the majority, he is asked to revise his opinion or indicate the reason or reasons for remaining in the majority (1973, 68).

Hostrup stated that the Delphi Technique has many practical uses in education. Included in his group was forecasting future curricular developments, determining state preferences, and establishing institutional goals (1973, 270).

The circumstances surrounding the group communication process determine the appropriateness of using the Delphi Technique. Linstone and Turoff (1975, 4) stated that one of the following properties of application indicates a need for the Delphi approach.

1. The problem does not lend itself to precise analytical techniques, but can benefit from subjective judgements on a collective basis.
2. More individuals are needed than can effectively interact in a face-to-face exchange.
3. Time and cost make frequent group meetings infeasible.
4. The heterogeneity of the participants must be preserved to assure validity of the results, i.e., avoidance of dominator by quantity or by strength of personality.

The study had all of these properties, and, therefore, the Delphi Technique was appropriate for utilization.

Procedure of Panel Selection

The Delphi Technique was selected because of the logistical problems of identifying and agreeing upon goals for energy technology education with a geographically diverse panel. The members of the panel were to be Industrial Arts Teacher Educators with knowledge of or involvement with energy technology education and associated with a Teacher Education Institution listed in the Industrial Teacher Education Directory, 1982-83 (E. Dennis).

To accomplish this, the department administrator of each department listed in the directory was asked to identify the member(s) of the department having knowledge of or

involvement with energy technology education. One-hundred-one individuals were identified at eighty institutions in the United States and Canada.

Development of Instrument

The first round questionnaire was developed from *The Establishment of Goals and Objectives for Energy Education Programs*, Gary Winek's dissertation completed in 1981 (University of Maryland). The goals from Winek's study were used because they represented the most comprehensive list available. The Industrial Arts Teacher Educators identified by their department administrators were presented with a list of Winek's goals and asked to indicate the level of importance they felt was appropriate for each goal. The participants' level of importance was expressed using a five choice numerical scale (see Appendix E).

A similar omission of the usual first step in a Delphi, asking participants to generate instructional responses to a general question, was used by Uhl in his research concerning the validation of an institutional goals inventory (Judd, 1972, 173).

Uhl cited the following benefits of his adaptation:

1. Time saved which would otherwise be required to collate and edit the usual round one responses to formulate questionnaire two.
2. Reduction of confusion when participants are not true experts and such individuals may appreciate a questionnaire they can respond to (Judd, 1972, 125).

Round one questionnaires were mailed to the panel members on September 27, 1983 with a requested return date of October 12, 1983. Eleven working days were provided for panel members to complete the questionnaire. Responses to questionnaire one were used to construct questionnaire two. Questionnaire two included the goals from questionnaire one along with the participants' group mean for each goal, providing feedback on round one group opinion (see Appendix F).

The participants were asked to reconsider the goal statements, then consider the group mean reported from round one. If the participants agreed with the mean of the first round, they were to circle the mean score reported to the left of the goal statement. If the participants disagreed with the mean generated from round one they were asked to circle the number corresponding to the level of importance they felt was appropriate to that goal.

Round two questionnaires were mailed to all panel members on October 28, 1983, with a requested return date of November 12, 1983. Ten working days were provided for panel members to complete the questionnaire. A self-addressed, post-paid return envelope was included with each questionnaire mailed.

CHAPTER 4

PRESENTATION AND INTERPRETATION OF DATA

Industrial education teacher educators with knowledge of and/or involvement with energy technology education comprised the panel of individuals involved in the study. A complete listing of respondents appears in Appendix A. The investigator attempted to assess the importance of selected energy technology education program goals, as perceived by nationally selected energy technology teacher educators. A series of two Delphi questionnaires were sent to panel members. The first round mailing requested that they react to a list of thirty-seven energy technology education program goals from Winek's dissertation indicating the level of importance, from low to high, they perceived for each goal. Group means for each goal were computed after round one and used as feedback to the panel for round two. In the second round of the Delphi, respondents were asked to concur with the group means or indicate the level of importance they felt appropriate if different from the mean.

Table 1. Mailing Rounds.

	No. Solicited	Round 1	Round 2
No. Sent	254 institutions	101	101
No. Responded	80 institutions, 101 individuals	73	75
Percentage	31%	73%	75%

The data in Table 1 were for the participation in the initial mailing utilized to establish the population for the study and the participation of the population in rounds one and two. Two-hundred fifty-four department administrators were requested to identify members of their department who had knowledge of an or involvement with energy technology

The Department of Agricultural and Industrial Education at Montana State University was intentionally omitted from all mailings as the energy technology teacher educators in that department served in the administration of the study.

	1 Instut. Program	2 Instut. Program	3 Instut. Program
No. of programs	64	10	6
Total number	64	20	18
% of total instut.	63	20	17

Table 3. GOAL 1. Six Forms of Energy.

[illegible]

The data in Table 3 were for the following goal: Energy technology education programs should provide the student with the six forms of energy (heat, light, chemical, mechanical, nuclear, electrical). The second round mean level of importance as perceived by the panel of energy technology teacher educators was 4.55. Between rounds one and two there was a shift in perceived level of importance from 4.54 to 4.55. The median from round two responses by the panel from this study, 4.86 was higher than the median from the third round of the Winek Study, 4.50.

Table 4. GOAL 2. Basic Energy Laws.

[illegible]

The data in Table 4 were for the following goal: Energy Technology Education Programs should provide the student with an understanding of basic energy laws. Between the first and second round there was a change in perceived level of importance from 4.42 to 4.43. The round two mean level of importance as perceived by the panel of energy technology teacher educators was 4.43. The median from the second round responses by the panel from this study, 4.21 was lower than the median from the third round of the Winek Study, 4.67.

Table 5. GOAL 3. Energy Applications.

[illegible]

The data in Table 5 were for the following goal: Energy Technology Education Programs should provide the student with an understanding of energy applications. The median from round two responses by the panel from this study, 4.93, was higher than the median from the third round of the Winek Study, 4.07. The round two mean level of importance as perceived by the panel of energy technology teacher educators was 4.67. Between rounds one and two there was a change in perceived level of importance from 4.55 to 4.67.

Table 6. GOAL 4. Background on Current Energy Problems.

[illegible]

The data in Table 6 were for the following goal: Energy Technology Education Programs should provide the student with knowledge of background information leading to the current energy problem. Between round one and two there was a change in perceived level of importance from 3.81 to 3.62. The round two mean level of importance as perceived by the panel of energy technology teacher educators was 3.62. The median from round two responses by the panel from this study, 3.72, was lower than the median from the third round of the Winek Study, 4.33.

Table 7. GOAL 5. Factors of United States Dependence on Energy.

[illegible]

[illegible]

Table 9. GOAL 7. United States Activities for Energy Independent Nation.

[illegible]

The data in Table 9 were for the following goal: Energy Technology Education Programs should provide the student with an understanding of the U.S. Government's activities in establishing an energy independent nation. The round two mean level of importance as perceived by the panel of energy technology teacher educators was 3.04. Between the first and second rounds there was a change in perceived level of importance from 3.16 to 3.04. The median from the second round responses by the panel from this study, 3.05, was lower than the round three median from the Winek Study, 3.83.

Table 10. GOAL 8. International Energy Supply and Demand.

[illegible]

The data in Table 10 were for the following goal: Energy Technology Education Programs should provide the student with an understanding of the international energy supply and demand pictures. Between rounds one and two there was a change in perceived level of importance from 3.70 to 3.56. The round two mean level of importance as perceived by the panel of energy technology teacher educators was 3.56. The median from round two responses by the panel from this study, 3.76, was lower than the median from the third round of the Winek Study, 4.17.

Table 11. GOAL 9. International Scope of Energy Problem.

[illegible]

The data in Table 11 were for the following goal: Energy Technology Education Programs should provide the student with an understanding of the International scope of energy problem. The median from round two responses by the panel from this study, 3.86, was lower than the median from the third round of the Winek Study, 4.67. The round two mean level of importance as perceived by the panel of energy technology teacher educators was 3.69. Between rounds one and two there was a change in perceived level of importance from 3.68 to 3.69.

Table 12. GOAL 10. Various Sources of Energy.

[illegible]

The data in Table 12 were for the following goal: Energy Technology Education Programs should provide the student with a knowledge of various sources of energy. Between the first and second round there was a change in perceived level of importance from 4.64 to 4.59. The round two mean level of importance as perceived by the panel of energy technology teacher educators was 4.59. The median from the second round responses by the panel from this study, 4.88, was lower than the median from the third round of the Winek Study, 4.94.

Table 13. GOAL 11. Advantages and Disadvantages of Energy Sources.

[illegible]

The data in Table 13 were for the following goal: Energy Technology Education Programs should provide the student with the knowledge to compare the advantages and disadvantages of current and probable energy sources. The second round mean level of importance as perceived by the panel of energy technology teacher educators was 4.50. Between rounds one and two there was a shift in perceived level of importance from 4.38 to 4.50. The median from round two responses by the panel from this study, 4.25, was lower than the median from the third round of the Winek Study, 4.88.

Table 14. GOAL 12. Various Means of Obtaining Energy.

[illegible]

The data in Table 14 were for the following goal: Energy Technology Education Programs should provide the student with a knowledge of the various means of obtaining energy. Between the first and second round there was a change in perceived level of importance from 4.10 to 4.15. The round two mean level of importance as perceived by the panel of energy technology teacher educators was 4.15. The median from the second round responses by the panel from this study, 4.08, was lower than the median from the third round of the Winek Study, 4.50.

Table 15. GOAL 13. Various Methods of Energy Transmission.

[illegible]

The data in Table 15 were for the following goal: Energy Technology Education Programs should provide the student with a knowledge of the various methods of energy transmission. The median from round two responses by the panel from this study, 3.99, was lower than the median from the third round of the Winek Study, 4.10. The round two mean level of importance as perceived by the panel of energy technology teacher educators was 3.95. Between rounds one and two there was a change in perceived level of importance from 3.97 to 3.95.

Table 16. GOAL 14. How Energy is Stored.

[illegible]

The data in Table 16 were for the following goal: Energy Technology Education Programs should provide the student with a knowledge of how energy is stored. Between rounds one and two there was a change in perceived level of importance from 4.00 to 4.03. The round two mean level of importance as perceived by the panel of energy technology teacher educators was 4.03. The median from round two responses by the panel from this study, 4.03, was lower than the median from the third round of the Winek Study, 4.50.

Table 17. GOAL 15. Fossil Fuel Energy Applications.

[illegible]

The data in Table 17 were for the following goal: Energy Technology Education Programs should provide the student with a knowledge of fossil fuel energy applications. The round two mean level of importance as perceived by the panel of energy technology teacher educators was 3.93. Between the first and second rounds there was a change in perceived level of importance from 3.97 to 3.93. The median from the second round responses by the panel from this study, 3.98, was higher than the round three median from the Winek Study, 3.83.

Table 18. GOAL 16. Nonfossil Fuel Energy Applications.

[illegible]

The data in Table 18 were for the following goal: Energy Technology Education Programs should provide the student with a knowledge of non-fossil fuel energy applications. The median from the second round responses from this study, 4.08, was higher than the median from round three of the Winek Study, 4.00. Between the first and second rounds of this study, there was a shift in perceived mean level of importance from 4.10 to 4.12. The round two mean level of importance as perceived by the panel of energy technology teacher educators was 4.12.

Table 19. GOAL 17. Energy Conservation Methods of Building Construction.

[illegible]

The data in Table 19 were for the following goal: Energy Technology Education Programs should provide the student with an understanding of energy conservation methods in building construction. The round two mean level of importance as perceived by the panel of energy technology teacher educators was 4.18. Between the first and second rounds there was a change in perceived level of importance from 4.21 to 4.18. The median from the second round responses by the panel from this study, 4.17, was lower than the round three median from the Winek Study, 4.88.

Table 20. GOAL 18. Energy Conservation Methods in Existing Dwellings.

[illegible]

The data in Table 20 were for the following goal: Energy Technology Education Programs should provide the student with an understanding of energy conservation methods in existing residential dwellings. Between rounds one and two there was a change in perceived level of importance from 4.23 to 4.27. The round two mean level of importance as perceived by the panel of energy technology teacher educators was 4.27. The median from the round two responses by the panel from this study, 4.23, was lower than the median from the third round of the Winek Study, 4.88.

Table 21. GOAL 19. Energy Conservation Methods in Industry.

[illegible]

[illegible]

Table 23. GOAL 21. Experiences and Activities for Prudent Energy Utilization.

[illegible]

The data in Table 23 were for the following goal: Energy Technology Education Programs should provide the student with experiences and activities to bring about prudent energy utilization. The second round mean level of importance as perceived by the panel of energy technology teacher educators was 3.26. Between rounds one and two there was a shift in perceived level of importance from 4.25 to 4.36. The median from round two responses by the panel from this study, 4.27, was lower than the median from the third round of the Winek Study, 4.94.

Table 24. GOAL 22. Basic Concepts of Energy Conversion.

[illegible]

The data in Table 24 were for the following goal: Energy Technology Education Programs should provide the student with an understanding of the basic concepts of energy conversion. Between the first and second round there was a change in perceived level of importance from 4.33 to 4.32. The round two mean level of importance as perceived by the panel of energy technology teacher educators was 4.32. The median from the second round responses by the panel from this study, 4.19, was lower than the median from the third round of the Winek Study, 4.83.

Table 25. GOAL 23. Information on Present Energy Conversion Devices.

[illegible]

The data in Table 25 were for the following goal: Energy Technology Education Programs should provide the student with information relevant to present day energy conversion devices. The median from round two responses by the panel from this study, 4.10, was higher than the median from the third round of the Winek Study, 3.83. The round two mean level of importance as perceived by the panel of energy technology teacher educators was 4.10. Between rounds one and two there was a change in perceived level of importance from 4.04 to 4.10.

Table 26. GOAL 24. Information on Future Energy Conversion Devices.

[illegible]

The data in Table 26 were for the following goal: Energy Technology Education Programs should provide the student with information related to future energy conversion devices. Between rounds one and two there was a change in perceived level of importance from 3.95 to 4.09. The round two mean level of importance as perceived by the panel of energy technology teacher educators was 4.09. The median from round two responses by the panel from this study, 4.09, was higher than the median from the third round of the Winek Study, 4.00.

Table 27. GOAL 25. Alternate Energy Sources.

[illegible]

The data in Table 27 were for the following goal: Energy Technology Education Programs should provide the student with a knowledge of alternate energy sources. The round two mean level of importance as perceived by the panel of energy technology teacher educators was 4.50. Between the first and second rounds there was a change in perceived level of importance from 4.49 to 4.50. The median from the second round responses by the panel from this study, 4.35, was lower than the round three median from the Winek Study, 4.88.

Table 28. GOAL 26. Environmental Impacts of Alternative Energy Sources.

[illegible]

The data in Table 28 were for the following goal: Energy Technology Education Programs should provide the student with an understanding of the various environmental impacts stemming from the use of alternative energy sources on society. The median from the second round responses from this study, 4.11, was lower than the median from round three of the Winek Study, 4.67. Between the first and second rounds of this study, there was a shift in perceived mean level of importance from 4.27 to 4.22. The round two mean level of importance as perceived by the panel of energy technology teacher educators was 4.22.

Table 29. GOAL 27. Implications of Various Alternative Energy Sources.

[illegible]

The data in Table 29 were for the following goal: Energy Technology Education Programs should provide the student with an understanding of the possible implications of choosing various alternative energy sources. The round two mean level of importance as perceived by the panel of energy technology teacher educators was 4.27. Between the first and second rounds there was a change in perceived level of importance from 4.22 to 4.27. The median from the second round responses by the panel from this study, 4.18, was lower than the round three median from the Winek Study, 4.67.

Table 30. GOAL 28. Impact on Lifestyles from Different Energy Options.

[illegible]

The data in Table 30 were for the following goal: Energy Technology Education Programs should provide the student with an understanding of the impact on lifestyles resulting from different energy options. Between rounds one and two there was a change in perceived level of importance from 3.91 to 3.67. The round two mean level of importance as perceived by the panel of energy technology teacher educators was 3.67. The median from round two responses by the panel from this study, 3.79, was lower than the median from the third round of the Winek Study, 4.33.

Table 31. GOAL 29. Ethical Issues in the Use of Energy.

[illegible]

The data in Table 31 were for the following goal: Energy Technology Education Programs should provide the student with an understanding of ethical issues in the use of energy. The median from round two responses by the panel from this study, 3.72, was lower than the median from the third round of the Winek Study, 4.50. The round two mean level of importance as perceived by the panel of energy technology teacher educators was 3.57. Between rounds one and two there was a change in perceived level of importance from 3.79 to 3.57.

Table 32. GOAL 30. Political Implications of Developing New Energy Resources.

[illegible]

The data in Table 32 were for the following goal: Energy Technology Education Programs should provide the student with an understanding of the political implications of developing new energy sources. Between the first and second round there was a change in perceived level of importance from 3.54 to 3.42. The round two mean level of importance as perceived by the panel of energy technology teacher educators was 3.42. The median from the second round responses by the panel from this study, 3.61, was lower than the median from the third round of the Winek Study, 3.90.

Table 33. GOAL 31. Social Implications of Developing New Energy Resources.

[illegible]

The data in Table 33 were for the following goal: Energy Technology Education Programs should provide the student with an understanding of the social implications of developing new energy resources. The second round mean level of importance as perceived by the panel of energy technology teacher educators was 3.66. Between rounds one and two there was a shift in perceived level of importance from 3.82 to 3.66. The median from round two responses by the panel from this study, 3.77, was lower than the median from the third round of the Winek Study, 4.33.

Table 34. GOAL 32. Economic Implications of Developing New Energy Resources.

[illegible]

The data in Table 34 were for the following goal: Energy Technology Education Programs should provide the student with an understanding of the economic implications of developing new energy resources. Between the first and second round there was a change in perceived level of importance from 4.13 to 4.03. The round two mean level of importance as perceived by the panel of energy technology teacher educators was 4.03. The median from the second round responses by the panel from this study, 3.99, was lower than the median from the third round of the Winek Study, 4.79.

Table 35. GOAL 33. Develop Ability to Solve Energy Problems.

[illegible]

The data in Table 35 were for the following goal: Energy Technology Education Programs should provide the student with experiences to develop the ability to solve energy problems. The median from round two responses by the panel from this study, 4.16, was lower than the median from the third round of the Winek Study, 4.88. The round two mean level of importance as perceived by the panel of energy technology teacher educators was 4.26. Between rounds one and two there was a change in perceived level of importance from 4.19 to 4.26.

Table 36. GOAL 34. Interrelationship Between Technology and Society in the Solution of Energy Problems.

[illegible]

The data in Table 36 were for the following goal: Energy Technology Education Programs should provide the student with experiences and activities demonstrating the interrelationship between technology and society in the solution of energy problems. Between rounds one and two there was a change in perceived level of importance from 3.92 to 3.88. The round two mean level of importance as perceived by the panel of energy technology teacher educators was 3.88. The median from round two responses by the panel from this study, 3.94, was lower than the median from the third round of the Winek Study, 4.88.

Table 37. GOAL 35. Ability to Research Energy Use in a Technological Society.

[illegible]

The data in Table 37 were for the following goal: Energy Technology Education Programs should provide the student with experiences to develop the ability to research energy use within a technological society. The round two mean level of importance as perceived by the panel of energy technology teacher educators was 3.92. Between the first and second rounds there was a change in perceived level of importance from 3.77 to 3.92. The median from the second round responses by the panel from this study, 2.69, was lower than the round three median from the Winek Study, 4.38.

Table 38. GOAL 36. Understanding of Available Consumer Energy Options.

[illegible]

The data in Table 38 were for the following goal: Energy Technology Education Programs should provide the student with experiences that lead to an understanding of available consumer energy options. The round two mean level of importance as perceived by the panel of energy technology teacher educators was 3.97. Between the first and second rounds there was a change in perceived level of importance from 3.94 to 3.97. The median from the second round responses by the panel from this study, 2.38, was lower than the round three median from the Winek Study, 4.50.

Table 39. GOAL 37. Understanding of Energy Options Available to Society as a Whole.

[illegible]

The data in Table 39 were for the following goal: Energy Technology Education Programs should provide the student with experiences leading to an understanding of energy options available to society as a whole. Between rounds one and two there was a change in perceived level of importance from 3.88 to 3.86. The round two mean level of importance as perceived by the panel of energy technology teacher educators was 3.86. The median from round two responses by the panel from this study, 3.24, was lower than the median from the third round of the Winek Study, 4.79.

Table 40. Rank of Major Area Headings by Mean Score of Component Goals' Means.

Major Area Heading	$\bar{X}$
Alternative energy sources	4.33
Energy conservation	4.17
Energy conservation	4.15
Basic energy information	4.02
Miscellaneous	3.98
Implications of energy decisions	3.67

The data in Table 40 were the ranking of the major area headings used in this study. The rank of the major area headings were determined by the mean score of the component goals' means. The major area heading, alternative energy sources, was highest in perceived level of importance, 4.33. The major area heading, implications of energy decisions, was lowest in perceived level of importance, 3.67.

Table 41. Rank of Combined Respondent Mean Scores (X) for Each Goal From Round 2.

$\bar{X}$	Rank Goal #	Descriptor
4.67	1	energy applications
4.59	2	various sources of energy
4.55	3	six forms of energy
4.50	4	advantages and disadvantages of energy sources
4.50	4	alternative energy sources
4.43	6	basic energy laws
4.36	7	experiences and activities bring about prudent energy utilization
4.32	8	basic concepts of energy conversion
4.27	9	energy conservation in existing dwellings
4.27	9	implications of various energy sources
4.26	11	develop ability to solve energy problems
4.22	12	environmental implications of alternative energy sources
4.18	13	energy conservation methods in building construction
4.15	14	various means of obtaining energy
4.12	15	nonfossil fuel applications
4.10	16	information on present energy conversion devices
4.09	17	information on future energy conversion devices
4.03	18	how energy is stored
4.03	18	economic implications of developing new energy resources
3.99	20	energy conservation methods in transportation
3.96	21	understanding of available consumer energy options
3.96	21	United States energy supply and demand
3.95	23	energy conservation methods in industry
3.95	23	various methods of energy transmission
3.93	25	fossil fuel energy applications
3.92	26	develop ability to research energy use in technological society
3.88	27	interrelationship between technology and society in the solution of energy problems
3.86	28	understanding of energy options available to society as a whole
3.69	29	international scope of energy problem
3.67	30	implications for lifestyles related to different energy options
3.66	31	social implications of developing new energy resources
3.62	32	background of current energy problems
3.59	33	factors of United States dependence on energy ethical issues of energy use
3.57	34	ethical issues of energy use
3.56	35	international energy supply and demand
3.42	36	political implications of developing new energy resources
3.04	37	United States activities for independent nation

The data in Table 41 were for the importance of goals as indicated by ranking of combined respondent mean scores for round two. The following goal, energy technology education programs should provide the student with an understanding of energy applications, had a round two mean level of importance of 4.67, the highest in the study. Goal number seven, energy technology education programs should provide the student with an understanding of the United States government's activities establishing an independent nation, had a round two mean level of importance of 3.04, the lowest in the study.

CHAPTER 5

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The purpose of this study was to determine the degree of importance of selected energy technology evaluation program goals according to nationally selected energy technology teacher educators. Specific objectives for the study were:

1. To assess the importance of selected energy technology education program goals, as perceived by nationally selected energy technology teacher educators.
2. To identify those industrial teacher education personnel who are involved with or have knowledge of energy technology education.

Historical and philosophical backgrounds of the energy problem, the role of energy technology education in general education and the development of energy technology education program goals were studied in the review of literature. It was found that the roots of the energy problem began with the industrial revolution. The energy problem was compounded by the United States becoming a net oil importer in 1957 and the continued expansion of an energy intensive society and lifestyle.

Although the energy problem has been in and out of the national limelight for the past ten years, relatively little work has been done to bring about energy technology education program development at the secondary education level.

The review of literature brought forward a set of energy technology education program goals developed by Gary Winek in 1979. Winek's study utilized ten leading energy technology educators to generate a set of energy technology education program goals.

Winek's study used the Delphi Method and at the end of the third round, thirty-seven goals had been identified by the panel. The thirty-seven energy technology education program goals resulting from Winek's study were the goals used in this study. The panel of experts used in this study were industrial teacher educators working at institutions listed in the 21st edition of the *Industrial Teacher Education Directory* (E. Dennis, ed.). The department administrators from each institution listed in the directory were contacted by letter. The administrators were asked to identify those individuals in their department who were involved with or had knowledge of energy technology education.

Two-hundred fifty-four administrators were sent letters. Of those administrators, ninety-three responded, eighty of those indicating they had appropriate individuals on staff.

One hundred-one energy technology teacher educators were identified and were sent first-round questionnaires. Seventy-three first-round participants provided the responses used to generate the first-round mean.

Round two provided each participant with the opportunity to agree with the mean of the first round responses or differ from the mean by selecting the level of importance they felt most appropriate for each goal. Seventy-five of the one-hundred one energy technology teacher educators identified by department administrators participated in the second round of the study. The data from the questionnaires were tabulated.

The results presented included round one and two means and round two median for each goal. The round two mean represented the mean level of importance of the particular energy technology education program goals as perceived by nationally selected energy technology teacher educators. The round two median was presented for comparison with the Winek Study.

Conclusions

After studying the results of the survey, some conclusions might be drawn. It may be concluded that, at the time of the study, those individuals identified by their department administrators as involved in and/or having knowledge of energy technology education maintained a high level of interest in energy technology education.

It may also be concluded that the overall level of importance of the goals presented was high. Of the major area headings the goals were divided into alternative energy sources was perceived as most important and implications for energy decisions was perceived as least important.

Recommendations

As a result of the findings and conclusions drawn from this study, the researcher offers several recommendations. Among those are the following:

1. Recommendation: That individuals or groups of individuals charged with program development in an industrial arts setting thoroughly review the most current international literature to develop a sound set of guiding goals for the entire industrial arts program. With a sound set of guiding goals for the entire program, each area specific program element, such as energy technology education, and its goals, could support, not detract from, the industrial arts curriculum.
2. Recommendation: That program goals developed with large input groups be reviewed and updated often.
3. Recommendation: That research efforts involving program development continue to seek the opinions of selected national experts, thus maintaining programming leadership.

4. Recommendation: That research efforts involving program development seek to involve as many field practitioners as possible to maintain some perspective on the current state of the profession as it is being implemented.

5. Recommendation: That further research be conducted comparing the goals developed in this study with the philosophical base established in the Montana Industrial Arts Planning Guide.

6. Recommendation: That similar program goal development be initiated for each of the major cluster areas including production, communication and transportation. The program goal development should examine the inputs, processes, outputs and feedbacks for each of the cluster areas.

BIBLIOGRAPHY

BIBLIOGRAPHY

- Adelson, Marvin; Alkin, Marvin C.; Ovey, Charles; and Helmer, Alafa. "The Education Innovation Study," *American Behavioral Scientist* 10 (March 1967): 2-29.
- Anderer, Jeanne. *Energy in a Finite World*. Cambridge, Massachusetts, Ballinger Publishing Company, 1981.
- Bender, Myron. Technology Education and Traditional Industrial Arts. *The Journal of Epsilon Pi Tau*, Fall 1982, VIII 2, 55-65.
- Benson, M. James. "Trends in Program Structure for Technology Education," *School Shop*, April 1981, 34-35.
- Burke, J. *Connections*, Boston: Little, Brown and Company, 1978.
- Combs, A. W. "What the Future Demands of Education," *Phi Delta Kappa*, 1981, 62(5), 369-372.
- Conby, Thomas Y. "Synfuels: Filler' Up? With What?" *National Geographic Magazine*, February 1981, pp. 74-95.
- Daiber, Robert A. Proceedings, Technology Education Symposium 80. Charleston, Illinois: Eastern Illinois University, 1980, p. 4.
- Dennis, Ervin A. (Editor). *Industrial Teacher Education Directory*, Cedar Falls, Iowa. The Wollverton Printing Company, 1982.
- DeVore, P. W. *Technology An Introduction*, Worchester, Massachusetts: Davis Publications, Inc. 1980.
- Dugger, Jr. W. E. et al. *Report of Survey Data of Standards for Industrial Arts Program Project*. Blackburg, Virginia. U.S. Office of Education, 1980.
- Dukert, Joseph M. "Projecting America's Energy Future," *Man Society Technology*, February 1981, pp. 4-7.
- Gilberti, Anthony F. "Technological Literacy: An Education for Tomorrow," Eastern Illinois University, 1983.
- Hales, James A. (Editor). *Jackson's Mill Industrial Arts Curriculum Theory*, Fairmont, West Virginia, Fairmont State College, 1980.
- Hostrup, Richard W. *Managing Education for Results*. Homewood, IC: ETC Publications, 1973.

- Jenks, Philip J. Proceedings, Technology Education Symposium 80. Charleston, Illinois: Eastern Illinois University, 1980, p. 4.
- Judd, Robert C. "Use of Delphi Methods in Higher Education," *Technological Forecasting and Social Change* (Winter 1972): 172-186.
- Kleine, Richard E. Proceedings, Technology Education Symposium 80. Charleston, Illinois: Eastern Illinois University, 1980, p. 11.
- Linstone, Harold A. and Turoff, Murray. *The Delphi Method: Techniques and Applications*. Reading, Massachusetts: Addison-Wesley, 1975.
- McCrory, David C. Proceedings, Technology Education Symposium 80. Charleston, Illinois: Eastern Illinois University, 1980, p. 6.
- Morgan, M. Granger (Editor). *Energy and Man: Technical and Social Aspects of Energy*. New York, New York: IEEE Press, 1975.
- Schwaller, Anthony E. (Editor). *Energy Technology: Sources of Power*. Worcester, Massachusetts, Davis Publications, Inc., 1980, p. XI.
- Schwaller, Anthony E. Proceedings, Technology Education Symposium 80. Charleston, Illinois: Eastern Illinois University, 1980, p. 10.
- Weaver, Kenneth F. "Our Energy Predicament." *National Geographic Magazine*, February 1981, pp. 2-23.
- Winek, Gary J. "The Establishment of Goals and Objectives for Energy Education Programs," Ph.D. dissertation, University of Maryland, 1981.

APPENDICES

APPENDIX A

QUESTIONNAIRE RESPONDENTS

APPENDIX A

QUESTIONNAIRE RESPONDENTS

Robert Anderson
Bridgeman Hall
Bemidji State University
Bemidji, MN 56601

Herbert J. Auer
Dept. of Industrial Tech
University of North Dakota
Grand Forks, ND 58202

Lyndol Aumiller
Dept. of Industrial Education
University of Maryland
College Park, MO 20742

Gregory Bazinet
Center for Industrial Education
University of Southern Maine
Gorham, ME 04038

Myron Bender
Dept. of Industrial Tech
University of North Dakota
Grand Forks, ND 58202

Richard Brooker
IET Dept.
EKU
Richmond, KY. 40475

Kenneth Brown
NWOSU
Alva, OK 73717

Hank Campbell
210 Turner Hall
Illinois State University
Normal, IL 61761

Robert Croker
Cleveland Hall
Washington State University
Pullman, WA 99164-2130

Fred Culpepper, Jr.
Vocational & Tech Education
Old Dominion University
Norfolk, VA 23508

Robert Dalley
IE & T Department
Western Carolina University
Cullowhee, NC 28723

Barry David
Dept. of Ind Ed & Tech
Ball State University
Muncie, IN 47306

William W. Davison
Central Connecticut State University
1615 Stanley Street
New Britain, CT 06050

Walter F. Deal
Vocational & Tech Education
Old Dominion University
Norfolk, VA 23508

James Delaura
Central Connecticut State University
1615 Stanley Street
New Britain, CT 06050

David Devier
Dept. of Industrial Tech
Ohio Northern University
Ada, OH 45810

Brian J. Donahue
Industrial Technology
Rm. 313, Rawl Bldg.
ECU
Greenville, NC 27834

Robert Donoho
Dept. of Industrial Tech
California State University
Chico, CA 95926

William Dugger, Jr.
Industrial Arts Ed
Virginia Poly Institute
Blacksburg, VA 24061

Sherill Dunham
Dept. Technology
University of Texas
Tyler, TX 75701

Louis G. Ecker
Dept. of IET
Central Michigan University
Mt. Pleasant, MI 48859

Bill Estrem
210 Turner Hall
Illinois State University
Normal, IL 61761

Stephen Fardo
Industrial Ed & Tech. Department
Eastern Kentucky University
Richmond, KY 40475

Howard Faulkner
Center for Industrial Education
University of Southern Maine
Gorham, ME 04038

Ray Fausel
5151 St. University Drive
Los Angeles, CA 90032

Richard L. Foley
Ind Ed & Tech Department
Keene State College
Keene, NH 03443

Edward Francis
210 Turner Hall
Illinois State University
Normal, IL 61761

Michael Giblin
Dept. of Industrial Education
Oregon State University
Corvallis, OR 97331

Ronald Gonzales
230 SNLB
Brigham Young University
Provo, UT 84602

James Gray
Dept. of Technology
Northern Kentucky University
Highland Heights, KS 41076

Martin Greenwald
Industrial Studies Department
Montclair State College
Upper Montclair, NJ 07043

Jerry Grover
230 SNLB
Brigham Young University
Provo, UT 84602

William Guentzier
5402 College Avenue
San Diego State University
San Diego, CA 92182

Robert Habingreither
Dept. of Technology
Southwest Texas State University
San Marcos, TX 78666

George Hache
Bag Ser 45333
Fredericton, NB Canada
6E3 5C2

Marshall Hahn
239 Greene Street
New York University
New York, NY 10003

Earling Hanson
Fitchburg State College
Fitchburg, MA 81420

John Henry
Industrial Studies Department
Montclair State College
Upper Montclair, NJ 07043

Jay Hicken
Ind Tech & Ed
UMC 60
Logan, UT 84322

Gus Hill
Agricultural Education Communications
University of Nevada Reno
Reno, NV 89557

Bill Hodgkinson
Box 3374 University Station
University of Wyoming
Laramie, WY 82071

Roger Hoover
University of Wisconsin
Platteville, WI 53813

Donald Hudson
Dept. of Industrial Arts
CPO 909 Berea College
Berea, KY 40404

Rick Hudson
School of Technology
Eastern Illinois University
Charleston, IL 61920

A. H. Jared
Dept. of Industrial Studies
University of Wisconsin
Platteville, WI 53818

Iver Johnson
Box 48, Ind & Tech Studies
Mankato State University
Mankato, MN 56601

Frank Jolly
Humboldt State University
Arcata, CA 95521

Wendell Jordan
P.O. Drawer R
University, AL 35486

Allan Kaufman
Vocational & Tech Education
Old Dominion University
Norfolk, VA 23508

Mohan Kim
306 Pioneer Tower
University of Wisconsin
Platteville, WI 53818

Ona Kay Kinter
4131 Forbes Quadrangle
University of Pittsburgh
Pittsburgh, PA 15260

Mr. Larry
Rm. 209, IEd II
Iowa State University
Ames, IA 50011

James LaPorte
107 Seitz Hall
Virginia Poly Inst & St. University
Blacksburg, VA 24061

Irving Larson
Bridgeman Hall
Bemidji State University
Bemidji, MN 56601

Ellis Lawrence
Box 96
Elizabeth City State University
Elizabeth City, NY 27909

James Lees
School of Technology
Kent State University
Kent, OH 44242

Billy MacMoore
P.O. Box 2266
Sam Houston State University
Huntsville, TX 77340

Cleo Martin
Southeastern Oklahoma St. University
Durant, OK 74701

Edmund J. Mannion
Dept. of Industrial Tech
California State University
Chico, CA 95926

W. D. Martin
Dept. of Tech
Eastern Washington University
Cheney, WA 99004

W. A. Mayfield
University of Texas
Tyler, TX 75701

Ronald McBride
The School of the Ozarks
Point Lookout, MO 65726

Howard McCalla
600 Venne H.E.
Suite 106
Arlington, TX 76011

Jim Miller
Dept. of Industrial Education
Kearney State College
Kearney, NE 68847

Larry Moeller
Rm. 219, IEd II
Dept. of IEd & Tech
Iowa State University
Ames, IA 50011

Lynn Mosher
California Polytech State University
San Luis Obispo, CA 93407

Ray Norris
Technology Complex 213A
Central Missouri State University
Warrensburg, MO 64093

James O'Bannon
Dept. of Industrial Tech
California State University
Chico, CA 95926

David Oscarson
Dept. of Technology
Pittsburg State University
Pittsburg, KS 66762

Art Palumbo
B650
School of Tech
Bowling Green, OH 43403

Winfield Parson
Industrial Studies Department
Montclair State College
Upper Montclair, NJ 07043

Joseph Pecosh
California State College
California, PA 15419

Randal Pierce
Room 427, Claxton Education Bldg.
University of Tennessee
Knoxville, TN 37996

John Preston
122 Sill Hall
Eastern Michigan University
Ypsilanti, MI 48197

Kirk Ready
Box 48
Industrial & Tech Studies
Mankato State University
Mankato, MN 56601

John Rhoades
Industrial Arts Education & Tech
Northwest Mo. State University
Maryville, MO 64468

Terry Richardson
Box 880
Northern State College
Aberdeen, SD 57401

Clair Hill
Industrial & Vocational Education
Northern Arizona University
Flagstaff, AZ 86011

Joseph Rinck
University of Wisconsin-Stout
Menomonie, WI 54751

Carlton Salvagin
Box 59-B
Hannibal, NY 13074

Nicolas Sanchez
New Mexico Highlands University
Las Vegas, NM 87701

Anthony E. Schwaller
Dept. of Industrial Education
College of Industry
St. Cloud State University
St. Cloud, MN 56301

Randall Shaw
Wayne State College
Wayne, NE 68787

Doug Smith
University of Nevada Reno
Reno, NV 89557

Michael Stewart
University of South Dakota
Springfield, SD 57062

Irving Strom
Bridgeman Hall
Bemidji State University
Bemidji, MN 56601

Alan R. Suess
313 Industrial Education Building
Purdue University
West Lafayette, IN 47907

R. W. Thornton
P. O. Box 13857
Denton, TX 76203

Charles R. Tutor
Western State College
Gunnison, CO 81230

W. D. Umstattd
Ohio State University
190 W. 19th Avenue
Columbus, OH 43210

Richard Vysocny
Northern Montana College
Havre, MT 59501

Douglas Walshom
Power & Energy Building
Valley City State College
Valley City, ND 58078

Grant Wells
VOTC Department
University of Vermont
Burlington, VT 05405

Robert Wenig
Room 300 Poe Hall
North Carolina State University
Raleigh, NC 27650

Jere Wheatley
Agricultural & Industrial Education
Montana State University
Bozeman, MT 59717-0002

William Whitaker
Dept. of Engineering Tech
Murray State University
Murray, KY 42071

Robert Wieking
Technology Department
Central Washington University
Ellensburg, WA 98926

A. Emerson Wiens
Bethel College
North Newton, KS 67117

Gary Winek
 Dept. of Technology
 Southwest Texas State University
 San Marcos, TX 68666

William Wolansky
 N-221A Quad
 Iowa State University
 Ames, IA 50011

James Yadon
 Engineering Technology
 Memphis State University
 Memphis, TN 38152

Allen Zimmerman
 Agricultural Engineering Building
 University of Vermont
 Burlington, VT 05405

APPENDIX B

**COMPARISON OF WINEK STUDY GOAL RANK
TO CRANDELL STUDY GOAL RANK**

APPENDIX B

COMPARISON OF WINEK STUDY GOAL RANK
TO CRANDELL STUDY GOAL RANK

Descriptor	Winek Rank	Winek Median	Crandell		Goal #
			Study Rank	Study Median	
various sources of energy	1	4.94	2	4.88	10
experiences and activities of prudent energy utilization	1	4.94	5	4.27	21
advantages and disadvantages of energy sources	3	4.88	6	4.25	11
energy conservation methods of building construction	3	4.88	11	4.17	17
energy conservation methods in existing dwellings	3	4.88	7	4.23	18
alternate energy sources	3	4.88	4	4.35	25
develop ability to solve energy problems	3	4.88	12	4.16	33
interrelationship between technology and society in the solution of energy problems	3	4.88	26	3.94	34
basic concepts of energy conversion	9	4.83	9	4.19	22
economic implications of developing new energy resources	10	4.79	23	3.99	32
understanding of energy options available to society as a whole	10	4.79	34	3.24	37
basic energy laws	12	4.67	8	4.21	2
United States energy supply and demand	12	4.67	22	4.01	6
international scope of energy problem	12	4.67	27	3.86	9
energy conservation methods in transportation	12	4.67	19	4.04	20
environmental impacts of alternative energy sources	12	4.67	13	4.11	26
implications of various alternative energy sources	12	4.67	10	4.18	27
six forms of energy	18	4.50	3	4.86	1
various means of obtaining energy	18	4.50	17	4.08	12
how energy is stored	18	4.50	20	4.03	13
ethical issues in use of energy	18	4.50	32	3.72	29
understanding of available consumer energy options	18	4.50	37	2.38	36
develop ability to research use in a technological society	23	4.38	36	2.69	35
background of current energy problem	24	4.33	15	4.09	4

Appendix B (continued)

Descriptor	Winek Rank	Winek Median	Crandell		Goal #
			Study Rank	Study Median	
impact on lifestyles from different energy options	24	4.33	28	3.79	28
social implications of developing new energy resources	24	4.33	29	3.77	31
factors of United States dependence on energy	27	4.30	30	3.76	5
energy conservation methods in transportation	27	4.30	21	4.02	19
international energy supply and demand	29	4.17	30	3.76	8
various methods of energy transmission	30	4.10	23	3.99	13
energy applications	31	4.07	1	4.93	3
nonfossil fuel applications	32	4.00	17	4.08	16
information on future energy conversion devices	32	4.00	15	4.09	24
political implications of developing new energy resources	34	3.90	33	3.61	30
United States activities for energy independent nation	35	3.83	35	3.05	7
fossil fuel energy applications	35	3.83	25	3.98	15
information on present energy conversion devices	35	3.83	14	4.10	23

APPENDIX C
COMPARISON TABLE

APPENDIX C

COMPARISON TABLE

Round 1 X	Round 2 X		Goal #	Descriptor
4.54	4.55	+01	1	six forms of energy
4.42	4.43	+01	2	basic energy laws
4.52	4.67	+15	3	energy applications
3.81	3.62	-.19	4	background on current energy problems
3.90	3.59	-.31	5	factors of United States dependence on energy
4.01	3.96	-.05	6	United States energy supply and demand
3.16	3.04	-.12	7	United States activities for energy independent nation
3.70	3.56	-.14	8	international energy supply and demand
3.68	3.69	+01	9	international scope of energy problem
4.64	4.59	-.05	10	various sources of energy
4.38	4.50	+12	11	advantages and disadvantages of energy sources
4.10	4.15	+05	12	various means of obtaining energy
3.97	3.95	-.02	13	various methods of energy transmission
4.00	4.03	+03	14	how energy is stored
3.97	3.93	-.04	15	fossil fuel energy applications
4.10	4.12	+02	16	nonfossil fuel energy applications
4.21	4.18	-.03	17	energy conservation methods of building construction
4.23	4.27	+04	18	energy conservation methods in existing dwellings
3.96	3.95	-.01	19	energy conservation methods in industry
3.96	3.99	+03	20	energy conservation methods in transportation
4.25	4.36	+11	21	experienced and activities for prudent energy utilization
4.33	4.32	-.01	22	basic concepts of energy conversion
4.04	4.10	+06	23	information on present energy conversion devices
3.95	4.09	+14	24	information on future energy conversion devices
4.49	4.50	+02	25	alternative energy sources
4.27	4.22	-.05	26	environmental impacts of alternative energy sources
4.22	4.27	+05	27	implications of various alternative energy sources
3.91	3.67	-.24	28	impact on lifestyles from different energy resources
3.79	3.57	-.22	29	ethical issues in the use of energy
3.54	3.42	-.12	30	political implications of developing new energy resources
3.82	3.66	-.16	31	social implications of developing new energy resources

Appendix C (continued)

Round 1 X	Round 2 X		Goal #	Descriptor
4.13	4.26	+07	33	develop ability to solve energy problems
3.92	3.88	-.04	34	interrelationship between technology and society in the solution of energy problems
3.77	3.92	+15	35	ability to research use in a technological society
3.94	3.96	+03	36	understanding of available consumer energy options
3.88	3.86	-.02	37	understanding of energy options available to society as a whole
4.04	4.02	-.02		OVERALL

APPENDIX D

LETTER TO DEPARTMENT ADMINISTRATORS



Montana State University
Bozeman, Montana 59717

Department of Agricultural and Industrial Education
College of Agriculture

TO: Department Administrators
FROM: Brian Crandell, Graduate Assistant, Curriculum Project
RE: Identification of Project Participants
DATE: May 4, 1983

The purpose of this letter is to solicit your help in identifying those individuals in your department who are involved with and informed about Energy Technology Education.

The individuals you identify will be asked to participate in a three-round modified delphi project to begin on or about October 1. This project will seek to update a list of Energy Technology Education Program competencies and measure the national consensus among the project's participants.

The results of this research will be used to guide the Energy Technology Education Program at Montana State University as well as Energy Technology Education Programs at the local level throughout Montana.

Please ask those individuals you have identified to complete the enclosed description worksheet and return it in the postpaid envelope.

Your response by May 23 will be appreciated.

BC/jrk
Enclosure

Telephone (406) 994-3201
Amberson, Polette, Bruwelheide, Roter, Wheatley
(406) 994-3691
Bishop, Shelhamer

APPENDIX E

FIRST ROUND QUESTIONNAIRE AND COVER LETTER



Montana State University
Bozeman, Montana 59717

Department of Agricultural and Industrial Education
College of Agriculture

September 27, 1983

Dear Participant:

In early May you were identified by your department administrator as an individual with knowledge of and involved in Energy Technology Education.

I am requesting your participation in a modified two-round Delphi information gathering process beginning with the enclosed instrument. This process is being used to update a list of Energy Technology Education program goals and major area headings and tabulate the participant group mean level of importance for each item.

The final round of this process will offer an opportunity to agree or disagree with the group mean level of importance for each item. The second round instrument will provide a means for you to request a copy of the results.

Sincerely,

Brian Crandell
Graduate Assistant
Curriculum Project

BC/jsk
Enclosure

Telephone (406) 994-3201
Amberson, Poirie, Bruwelheide, Roster, Wheatley
(406) 994-3691
Bishop, Shelhamer

First Round Questionnaire
Return by October 12, 1983

DIRECTIONS:

Read each goal statement or major area heading carefully, then rate each goal statement or major area heading on the 1 to 5 scale provided. This rating is to be based on the importance you believe the goal or major area heading should have for an Energy Technology Education program. If you have no opinion regarding a particular goal statement or major area heading, please leave the corresponding scale blank.

	1	2	3	4	5	
						Very Low Importance
						Low Importance
						Moderate Importance
						High Importance
						Very High Importance
	1	2	3	4	5	EXAMPLE: Each project participant will fill out this questionnaire completely and return it by October 12, 1983.
	1	2	3	4	5	<u>Major Area Heading - Basic Energy Information</u> Note: The goals listed below will use the following stem: Energy Technology Education Programs should provide the student with:
1.	1	2	3	4	5	an understanding of the six forms of energy (heat, light, chemical, mechanical, nuclear, electrical).
2.	1	2	3	4	5	an understanding of basic energy laws.
3.	1	2	3	4	5	an understanding of energy applications.
4.	1	2	3	4	5	knowledge of background information leading to the current energy problem.
5.	1	2	3	4	5	an understanding of the factors relating to the United States dependence on energy.
6.	1	2	3	4	5	an understanding of the United States energy supply and demand picture.
7.	1	2	3	4	5	an understanding of the United States Governments' activities in establishing an independent nation.
8.	1	2	3	4	5	an understanding of the international energy supply and demand picture.
9.	1	2	3	4	5	an understanding of the international scope of the energy problem.
10.	1	2	3	4	5	a knowledge of various sources of energy.
11.	1	2	3	4	5	the knowledge to compare the advantages and disadvantages of current and probable energy sources.
12.	1	2	3	4	5	a knowledge of the various means of obtaining energy.
13.	1	2	3	4	5	a knowledge of the various methods of energy transmission.
14.	1	2	3	4	5	a knowledge of how energy is stored.
15.	1	2	3	4	5	a knowledge of fossil fuel energy applications.
16.	1	2	3	4	5	a knowledge of non-fossil fuel applications.
	1	2	3	4	5	<u>Major Area Heading - Energy Conservation</u> Note: The goals listed below will use the following stem: Energy Technology Education Programs should provide the student with:
17.	1	2	3	4	5	an understanding of energy conservation methods used in building construction.
18.	1	2	3	4	5	an understanding of energy conservation methods in existing residential dwellings.
19.	1	2	3	4	5	an understanding of energy conservation methods in industry.
20.	1	2	3	4	5	an understanding of energy conservation methods used in transportation.
21.	1	2	3	4	5	experiences and activities to bring about prudent energy utilization.
	1	2	3	4	5	<u>Major Area Heading - Energy Conversion</u> Note: The goals listed below will use the following stem: Energy Technology Education Programs should provide the student with:
22.	1	2	3	4	5	an understanding of the basic concepts of energy conversion.
23.	1	2	3	4	5	information relevant to present day energy conversion devices. (Examples - gasoline engines, steam engines, generators, etc.)
24.	1	2	3	4	5	information related to future energy conversion devices. (Examples - fusion, magnetohydrodynamics).

Major Area Headings and Goal Statements have been obtained from Winek, Gary J, "The Establishment of Goals and Objectives for Energy Education Programs", Phd Dissertation, University of Maryland, 1981

APPENDIX F

SECOND ROUND QUESTIONNAIRE AND COVER LETTER



Montana State University
Bozeman, Montana 59717

Department of Agricultural and Industrial Education
College of Agriculture

October 29, 1983

Dear Participant:

With the enclosed final round instrument, I am requesting your continued participation in a modified two-round Delphi information gathering process. This process is being used to update a list of Energy Technology Education program goals and major area headings and to tabulate the participant group mean level of importance for each item. As you begin the questionnaire, please note the new directions.

The interest, quick response, and thoughtful consideration shown by the participant group is sincerely appreciated. Thank you for your prompt attention to this second-round questionnaire.

Please return your questionnaire by Thursday, November 10.

Sincerely,

Brian Crandell
Graduate Assistant
Curriculum Project

BC/jrk
Enclosure

Telephone (406) 994-3201
Amberson, Polette, Bruwelheide, Roster, Wheatley
(406) 994-3691
Bishop, Shelhamer

Second Round Questionnaire
Please Return by November 10, 1983

DIRECTIONS: 1. Please read each goal statement and major area heading carefully, noting the group mean score ($\bar{x}$) indicated to the left. 2. If your opinion is the same as that of the majority, circle the mean score. 3. If your opinion differs from that of the majority, please circle the number corresponding to the level of importance you feel is appropriate. 4. Following the last goal statement, please fill in the course rubric and title for the energy course(s) you have taught. 5. If you would like a copy of the results of this study, please supply your name and address at the bottom of page two.

$\bar{x}$			Very Low Importance	Low Importance	Moderate Importance	High Importance	Very High Importance	
(5)			1	2	3	4	5	EXAMPLE: Each project participant will fill out this questionnaire completely and return it by November 10, 1983.
4.30			1	2	3	4	5	<u>Major Area Heading</u> - Basic Energy Information Note: The goals listed below will use the following stem: Energy Technology Education Programs should provide the student with:
4.54	1.		1	2	3	4	5	an understanding of the six forms of energy (heat, light, chemical, mechanical, nuclear, electrical).
4.42	2.		1	2	3	4	5	an understanding of basic energy laws.
4.55	3.		1	2	3	4	5	an understanding of energy applications.
3.81	4.		1	2	3	4	5	knowledge of background information leading to the current energy problem.
3.90	5.		1	2	3	4	5	an understanding of the factors relating to the United States dependence on energy.
4.01	6.		1	2	3	4	5	an understanding of the United States energy supply and demand picture.
3.16	7.		1	2	3	4	5	an understanding of the United States Governments' activities in establishing an independent nation.
3.70	8.		1	2	3	4	5	an understanding of the international energy supply and demand picture.
3.68	9.		1	2	3	4	5	an understanding of the international scope of the energy problem.
4.64	10.		1	2	3	4	5	a knowledge of various sources of energy.
4.38	11.		1	2	3	4	5	the knowledge to compare the advantages and disadvantages of current and probable energy sources.
4.10	12.		1	2	3	4	5	a knowledge of the various means of obtaining energy.
3.97	13.		1	2	3	4	5	a knowledge of the various methods of energy transmission.
4.0	14.		1	2	3	4	5	a knowledge of how energy is stored.
3.97	15.		1	2	3	4	5	a knowledge of fossil fuel energy applications.
4.10	16.		1	2	3	4	5	a knowledge of non-fossil fuel applications.
			1	2	3	4	5	<u>Major Area Heading</u> - Energy Conservation Note: The goals listed below will use the following stem: Energy Technology Education Programs should provide the student with:
4.21	17.		1	2	3	4	5	an understanding of energy conservation methods used in building construction.
4.23	18.		1	2	3	4	5	an understanding of energy conservation methods in existing residential dwellings.
3.96	19.		1	2	3	4	5	an understanding of energy conservation methods in industry.
3.96	20.		1	2	3	4	5	an understanding of energy conservation methods used in transportation.
4.25	21.		1	2	3	4	5	experiences and activities to bring about prudent energy utilization.
4.06			1	2	3	4	5	<u>Major Area Heading</u> - Energy Conversion Note: The goals listed below will use the following stem: Energy Technology Education Programs should provide the student with:
4.33	22.		1	2	3	4	5	an understanding of the basic concepts of energy conversion.
4.04	23.		1	2	3	4	5	information relevant to present day energy conversion devices. (Examples - gasoline engines, steam engines, generators, etc.).
3.95	24.		1	2	3	4	5	information related to future energy conversion devices. (Examples - fusion, magnetohydrodynamics).

OVER

-2-

		Very Low Importance Low Importance Moderate Importance High Importance Very High Importance					
		1	2	3	4	5	
4.43							Major Area Heading - Alternative Energy Sources Note: The goals listed below will use the following stem: Energy Technology Education Programs should provide the student with:
4.49	25.	1	2	3	4	5	a knowledge of alternative energy sources.
4.27	26.	1	2	3	4	5	an understanding of the various environmental impacts stemming from the use of alternative energy sources on society.
4.22	27.	1	2	3	4	5	an understanding of the possible implications of choosing various energy alternatives.
4.10							Major Area Heading - Implications of Energy Decisions Note: The goals listed below will use the following stem: Energy Technology Education Programs should provide the student with:
3.91	28.	1	2	3	4	5	an understanding of the impact on life styles resulting from the use of different energy options.
3.79	29.	1	2	3	4	5	an understanding of ethical issues in the use of energy.
3.54	30.	1	2	3	4	5	an understanding of the political implications of developing new energy resources.
3.82	31.	1	2	3	4	5	an understanding of the social implications of developing new energy resources.
4.13	32.	1	2	3	4	5	an understanding of the economic implications of developing new energy resources.
3.13							Major Area Heading - Miscellaneous Note: The goals listed below will use the following stem: Energy Technology Education Programs should provide the student with:
4.19	33.	1	2	3	4	5	experiences to develop the ability to solve selected energy problems.
3.92	34.	1	2	3	4	5	experiences and activities demonstrating the interrelationship between technology and society in the solution of energy problems.
3.77	35.	1	2	3	4	5	experiences to develop the ability to research energy use within a technological society.
3.94	36.	1	2	3	4	5	experiences that lead to an understanding of available consumer energy options.
3.88	37.	1	2	3	4	5	experiences leading to an understanding of energy options available to society as a whole.

Major Area Headings and Goal Statements have been obtained from Winek, Gary J. - "The Establishment of Goals and Objectives for Energy Education Programs", Phd Dissertation, University of Maryland, 1981.

Please supply the following information about the energy course(s) you have taught.

Rubric Title

(Example) IA 202 Power and Energy

If you would like a copy of the results of this study, please supply your name and address.

Name _____

Address _____

THANK YOU for your valuable participation.