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A SYSTEMS APPROACH

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ENVIRONMENTAL PROFESSIONAL DEVELOPMENT:

A SYSTEMS APPROACH

APPROVED BY

DISSERTATION COMMITTEE

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TOWARD NEW PERCEPTIONS

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Background

To better understand our world, the system of American higher education has extended the principle of reductionism by the identification, development, and academic devotion to single independent disciplines. The predilection that the disciplines remain pure by isolation has caused serious and widespread repercussions throughout all levels of educational systems by diverting attention from larger learning considerations as evidenced mainly by student critique and societal dissatisfaction.

All too frequently, environmental academic candidates are subject to training in considerable depth in a single discipline or substantive area, such as air pollution or water resources, whereas a serious need exists to provide training experiences which integrate the functional aspects of the various organized catagories of the environment with particular emphasis on such operational approaches as aggregate design and systems management.

The world we live in is changing extremely rapidly, and thus the ways people organize themselves to prepare their young to be useful citizens and to cope with change must also change. Cities and peoples the world over share environmental problems--pollution, overcrowding, poverty, health--as well as shortages (or threatened ones) of power, water, housing, schools, sanitary facilities, and mass transportation. The dilemmas of human settlements were of first priority on the agenda of the Stockholm Conference, and CONFLEX '76 will be developed by UNEP in Canada on the "built environment". Engineers trained to cope with public problems will be required in increasing numbers, particularly because the interdependency of the various facets of the human environment and natural resources require not only the design of facilities and processes but also their interactions and impacts. Thus, engineers should be capable of recognizing impacts in advance of design decisions by synthesizing the parts together over time.

Engineers trained in environmental concerns will be needed to function in operation, management, design, investigation, and planning in such catagories as water, air, noise, air pollution, and liquid and solid wastes. Actually, an extension of capability to handle other social and economic areas--housing, power, transportation--as part of the overall planning process, is essential. The foreshortening of a responsive time frame and the long-term investment required for adequate training necessitates looking at alternatives in advance. To be properly responsive to future needs, and engineer's preparation must recognize the tools and substance of the future solution of problems. One must be capable of understanding the whole system including its economics, data, processes, goals and alternatives, components and arrangements, measures of effectiveness, forecasting futures, and analytical tools. The need to study and evaluate curricula matters in this context is serious and universal.

The Challenge

The future of engineering and the requirement for the practitioner to function as a meaningful part of the public decision-making process in the growth and development of society depends to a great extent on the formal education of the professional engineer. The challenge to the educator involves contributing to the intellectual, social, and psychological growth of the student and exploring the environment in which the graduate will be expected to function. The task is to translate the projected needs of society and the profession into a meaningful educational program within the constraints of the *in situ* system with recommendations for modification, if required. In essence, this means building an educational foundation to equip the graduate to successfully cope with problems of alternative futures. The need is to provide a view of the profession within the context of society and describe the ways the technical specialty bears on human life.

A higher challenge to the educator which contributes to the development of the student concerns the articulation and planned transmission of a value system through a clarification of fundamental convictions basic to our culture. An appropriate value system may point the way to responsible problem solving by selecting solutions that are truly compatible with human needs and the natural environment.

A third significant challenge is inculcating each student with a higher sense of professional responsibility in decisions relative to social, political, and ecological ramifications. This broadens the role of the practicing engineer and calls for an accounting for one's actions. The graduate should understand that the engineer and those who use science and technology should exercise their profession within a framework of fundamental convictions and with a clear awareness of the enormous influence which their activities can have. Stress should be placed on developing a social conscience, moral discipline, and sense of direction. One's exercise of professional values is at least as important as one's store of technical knowledge.

Traditional Response

Historically, the engineer, as a result of his specialized reductionist training, has been seemingly isolated from the total human system and has been proffered as a technical expert (advice giver) or problem solver (specialist) with little or no real substantive relationship to other critical factors of society. As a consequence, problem solutions usually did not include the generation of viable alternatives in consideration of social, political, and ecological systems describing the larger societal setting in which the problem was embedded. The apparent lack of a broad sense of professional responsibility has resulted in situations where the engineer has been accused of being party to the creation of compound problems instead of solving them. This manifestation is a reflection of the deepest problems of our educational systems.

Perhaps the basic organization and structure of knowledge into disciplines may be a major difficulty of educational systems and academic reform. If disciplinary conventions are to be changed or eliminated, different managements or central elements of education have been suggested:

1. Environmental approach to education (Train, Lukco).

2. Futures studies (Toffler: xxv, and authors).

3. Interdisciplinary (Train: 16; and others).

The intent of these strategies is to alter or reform the educational process so that the individual may gain a clear, undistorted perception of the world and understand the place of humankind. (The scope of this study does not include the resolution of these alternatives but certainly recommends this concern for future exploration.)

One of the glaring ironies of contemporary professional education is that most programs try to prepare students to function in a time that does not yet exist by developing their studies on a time that has ceased to exist. Traditional systems which are present- and past-bound tend to perpetuate this dilemma by responding to changing societal needs incrementally with numerous over-shoots and a tendency to over-identify, add-on, and/or needlessly duplicate studies. This tends to isolate and immobilize an educational system. As society lurches from one crisis to the next, educational responses follow, patching here and there, with no real program to adequately satisfy needs. Minor adjustments in the framework of existing reactive systems, which futilely pretend to be responsive by simply adding new courses or modifying old course contents, simply cannot produce the required rapid and appropriate response to the changing needs of human affairs.

Since present attempts at educational restructuring are badly outpaced by fast moving economic, social, and technological events, the requirement is to develop an anticipatory form of curriculum to break short-term approaches to academic reform. (Figure I-1)

In addition, ad hoc curriculum review committees may often be

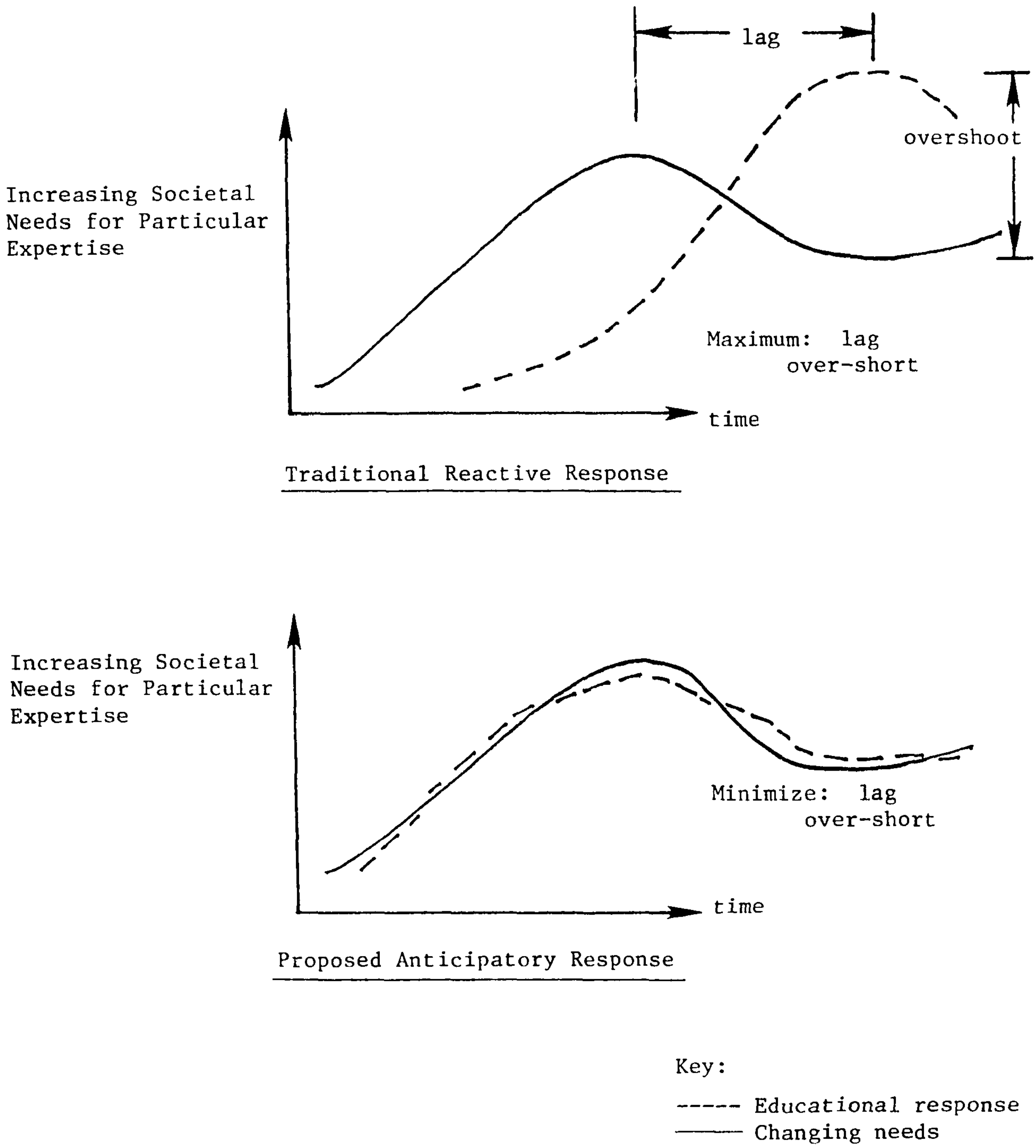


Figure I-1, EDUCATIONAL RESPONSE

structured and committed to the maintenance of the status quo in response to the firmly implanted institutional organization and administration. It is suggested that ways need to be found to transcend these dilemmas.

These factors emphasize the fundamental needs toward which this project is directed.

PROPOSED RESPONSE

Concepts

Responsive change calls for the systematic evaluation of the educational experience in light of the forecasted expanded concept of the roles of the engineer in society. In addition to technical competence, a social responsibility to safeguard and improve the quality of the human environment, coupled with an interdisciplinary systems approach, constitute the basic elements of the educational experience.

An enlightened effort by educators is needed to broaden the curriculum design decision-making envelope by taking into account the projected changing needs of a circumambient society and matching those needs with the capabilities of the graduate during some future-focused time period after graduation. In this way, the time-phase lag between societal needs and professional contributory capabilities are minimized.

The proposed response recognizes and responds to the requirement that engineering practitioners must expand their horizons beyond a specialized technology to include a familiarity, understanding, and respect for different disciplines and professions. This is an essential element for the full understanding of the impact of individual professional activities on society as a whole.

This response attempts to suggest a significant contribution to the educational scene which perhaps has not been attempted before in this way; that is, the incorporation of integrative studies involving a concept of a higher sense of responsibility through value system exploration and clarification of fundamental convictions. Although values may not be presented as absolute, exposure to these concepts are designed to provide the graduate with devices which give direction, meaning, and evaluation to academic studies as well as future professional activities.

This effort requires a broader perspective by a fresh approach to the problems of education and not just accepting conventional terms and conventional ways of doing things. A fresh look at education as manifested in this text, necessitates a de-emphasis of the traditional educational developments such as presentation methods and media, audio-visual techniques, individualized instruction, and others. Although these subjects may be of extreme interest and the focus of vital concerns elsewhere, in this study they are intentionally suppressed so that a perspective of the educational system as a whole may be more clearly visualized and opportunities more clearly perceived. The procedure may be described as trying to stand back from the trees so that the forest may be viewed as a complete system.

How well these efforts succeed in accomplishing any of the objectives may be partially judged by this report. In the final analysis, however, the major accomplishment may be in what each reader derives and the forces which may be set in motion.

Specific decisions as to detailed course outlines, sequencing, and pacing of instruction are minimized and intended to be the subject of educator and institutional judgement at the particular local unit to fit local requirements.

Specific Plan of Action

If this proposal may be construed as a manifesto, it must lead to action, for failure to do so renders this effort meaningless. The action is contained in the curriculum, course descriptions, and strategies for implementation.

I General Strategy

Phase I - The development of a complete training program was initiated by the development and presentation of a single interdisciplinary trial course and preliminary attitudinal evaluation. (Appendix A)

Phase II - This part of the study encompasses the development of specific curricula format and course descriptions as a positive solution for educational institutions and agencies to consider and evaluate.

II Timetable

Design-planning - This report presents Phase II which involves the analysis of the specific educational problem in the light of the professional and educational setting followed by the development of curricula designed to elicit desired behavior patterns of the graduate. The program and courses were generated and evaluated in consultative conferences with concerned educators and consumers. The final curricula and courses are to be presented for possible adoption at the University of Oklahoma and other institutions.

Implementation - Tentative implementation action was begun with the offering of a trial course. The experience and evaluation gained from the exercise provided guidelines for other course descriptions. Objective measures by examination or other methods will provide a means of checking to determine whether or not the program meets planned objectives. Each course will be subjected to the same implementation pattern. (Full program implementation strategy planning is an area for further work and investigation outside the scope of this study.)

Revision - Optimization results from the feedback of information from the testing of each course and program presentation. It must be emphasized that this development procedure is reiterative and dynamic and is dependent on constant review and responsible adjustment for its success.

THE EDUCATIONAL PROBLEM

The emphasis and value placed on education by our society has always enjoyed a prominent position and is generally accepted as the key to almost everything. America's educational system is our central agency for human development... (Bloomfield: 225). Answers to the dangers and complexities of modern life are commonly held in more and better education. The function of education is to try to understand our environment and our place in the universe. However, a great deal of confusion exists in defining appropriate patterns because and educational system is a social system and therefore represents people, their decisions, and their reactions to the pressures of their environment. In the pursuit of unique careers, such as those relating to environmental concerns, there is no absolute authority that can specify which knowledge, skills, and training will best support a given career. Education is a personal thing and the individual must make those judgments and focus on areas in which the individual has an active interest. However, career choices are often tentative and will more than likely be modified. Educators must recognize and account for this (Mood). As the graduate progresses in his chosen area, he will encounter unique situations and his education must prepare for those now unforeseen conditions.

In designing an educational system, it is important to acknowledge at the outset the practical impossibility of producing a universal curriculum applicable to across-the-board environmental concerns especially at the graduate level. The charge of engineering is embodied in the systems approach which must be presented in terms of substance and tools toward analysis, synthesis, design, optimization, and implementation. Emphasis should be placed on providing a platform for interdisciplinary and multi-professional group action for both students and faculty.

If the program is to effectively interrelate and interpret observations in the field of environmental concerns, of critical concern is the requirement for a suitable structure for a continuously developing and responsive set of goals which express a reasonable assessment of the future problems of people. Without an integrating, organizing, and goal-oriented structure, information remains a hodgepodge of fragments, and knowledge is only a collection of observations, practices, and conflicting incidents. Without such a goal-oriented structure, it is difficult to learn from experience or to use the past to educate for the future.

PURPOSE OF STUDY

The basic purpose of this study is to devise a more responsive system of training at the Masters Degree level aimed at producing engineering graduates for work in environmental areas of concern. The program was designed to ensure the elimination of course and subject redundancy and optimize course packaging, thus striving to reduce course offerings and to provide course groupings amenable to change.

A revised system of training involves new dimensions of study specifically designed to illuminate those elements which seem to be lacking in traditional systems. This study stands on the threshhold of introducing a new educational emphasis and organization.

PLAN OF STUDY

Overall, the study was organized into three activities: (1) the collection of data on social, educational, and engineering trends pertaining to graduate environmental educational programs; (2) review, consideration, and discussion of the mass of literature, reports, and analyses; and (3) drafting this proposal for presentation to educators for critique and finally as a prospective program. These activities proceeded in a manner that promoted an interacting and reiterative study methodology. The primary emphasis of investigation shifted sequentially over time from one activity to another.

Initial attention was directed to two areas of study: the professional setting to gain an insight into engineering activities, and the educational setting to better understand the educational experience as a mechanism for delivering the training program. From this base of information, development of curricula was possible by first developing a series of statements describing the educational philosophy of the program, followed by specific statements of program objectives which, in turn, led to course development including course content and associated teaching strategies. Figure I-2 is a graphic representation of the study plan, while Table I-1 depicts the research rationale.

SCOPE AND LIMITATIONS

This study was undertaken to investigate the needs of only one particular segment of the educational panorama (that is, at the masters level) and addresses educational elements relating to environmental concerns. (Figure I-3) It is directed toward a student who may migrate from engineering to civil engineering to an environmental specialty and be qualified to progress to research. It does not build on a standard environmental undergraduate program.

The overall approach is analytical and only partially prescriptive. The suggested program is not performance or job-oriented but rather is conceptually or activity oriented.

It is readily acknowledged that the study does not represent an educational panacea either in terms of a rational analysis of the educational problem or the resultant program. Each institution must deal with its own opportunities and constraints regarding resources, support, and market needs. This curricula is one response to a spectrum

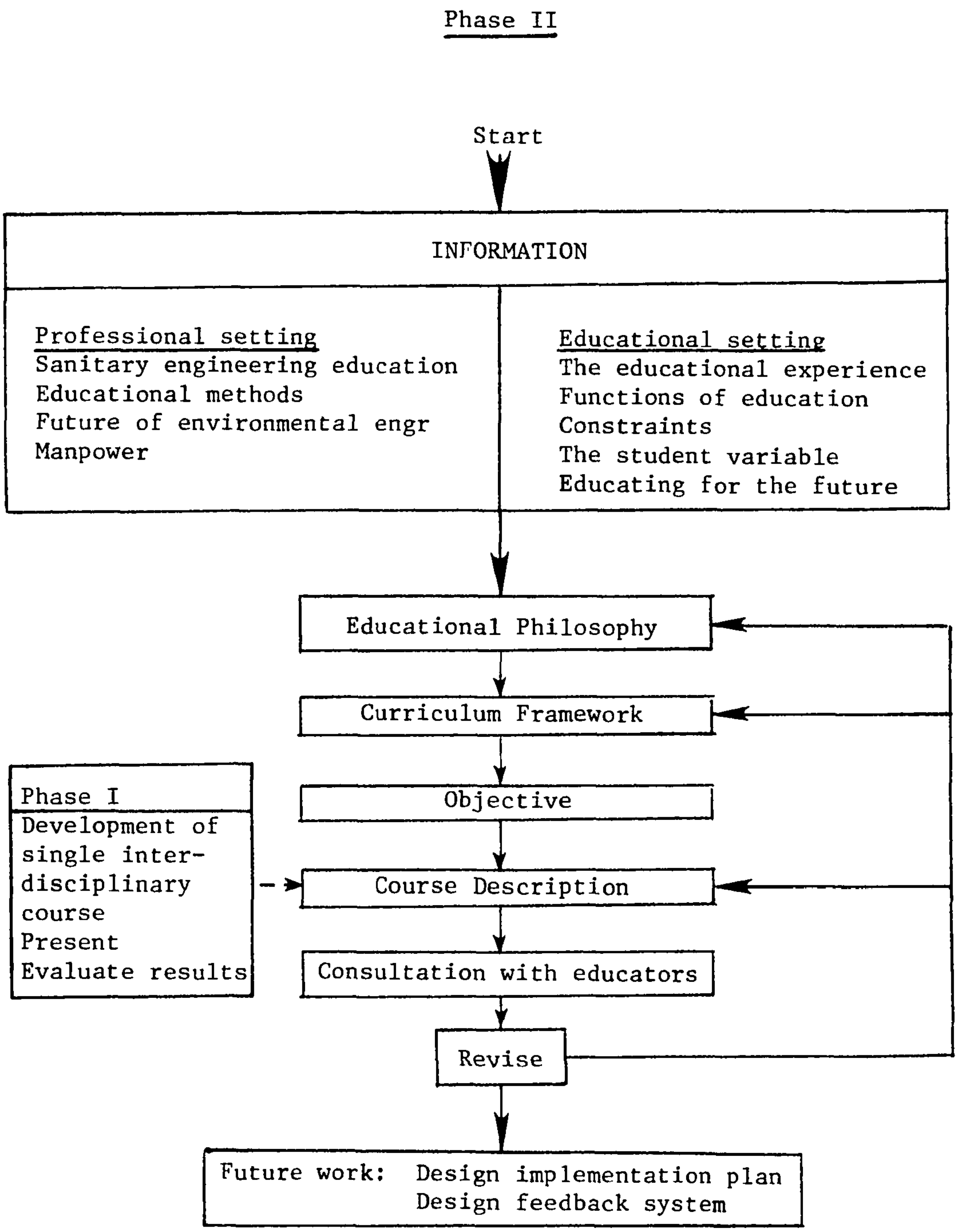


Figure I-2, PLAN OF STUDY

RESEARCH RATIONALE

EVENT	PURPOSE
Undertake program of study	To devise a responsive system of training at the masters degree level.
Gather information on:	
Curricula in use, (what, how, is being taught)	To determine characteristics of current programs.
Educational experience, (Institutional and student characteristics)	To determine the institutional and student constraints which the proposed program must fit.
Professional activities, (Historical and future roles)	To determine areas of future professional needs.
Reiterative concept: Design of Proposed Program	
Analysis of information, experience, and consultations.	To establish desired program characteristics, educational philosophies, and objectives different from current programs.
Description of curriculum framework.	To reflect educational and other constraints.
Description of courses, including alternative training styles.	To reflect future needs of profession, society, and the student.
Testing of one course: "Urban Environmental Systems"	To determine student reaction to subject matter relevancy, appropriateness, and contribution to knowledge.
Presentation of results.	To evaluate, critique, and revise program.

Table I-1, RESEARCH RATIONALE

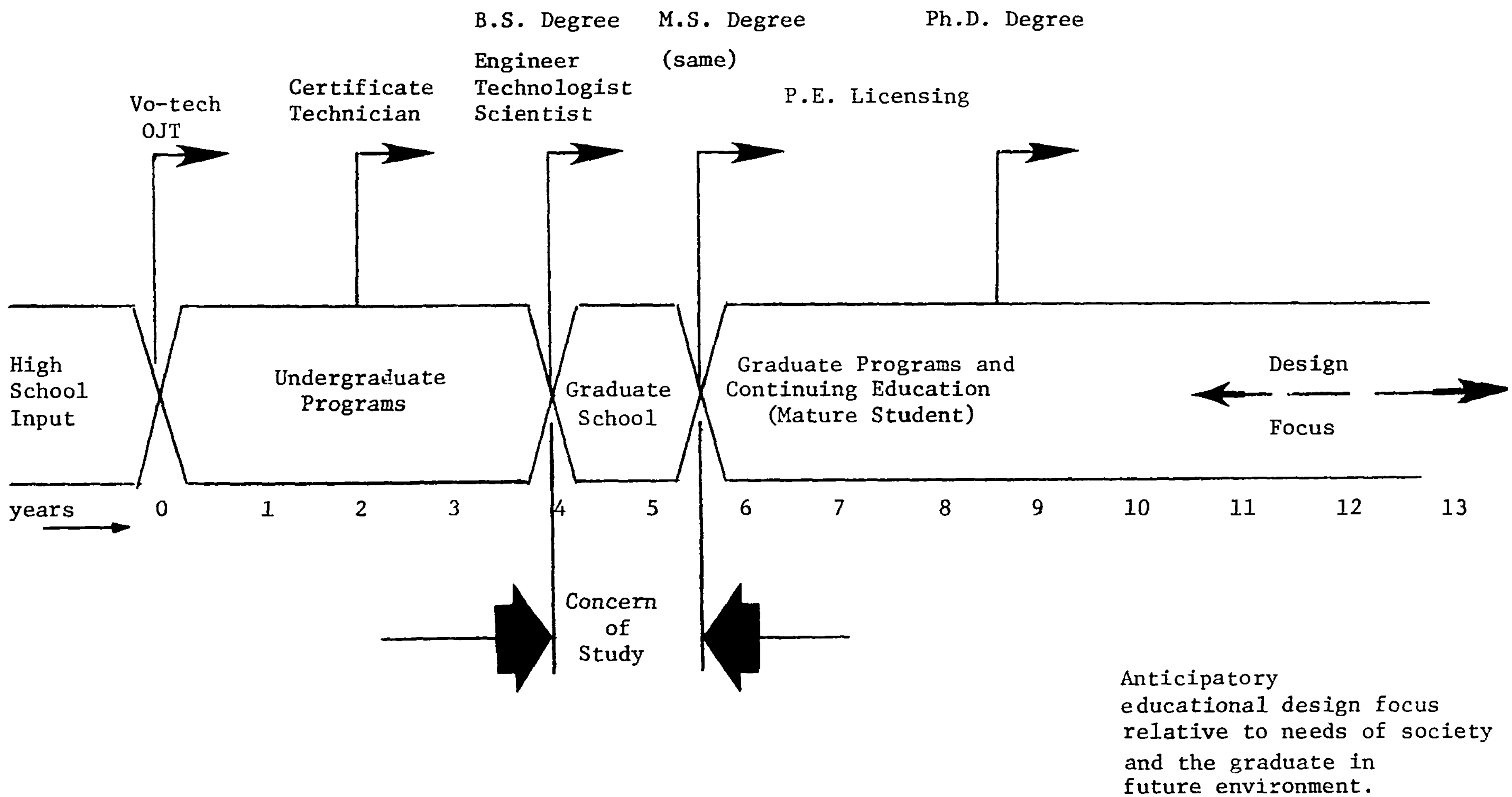


Figure I-3, FORMAL EDUCATIONAL STRUCTURE of possible pluralistic educational responses. The study is meant to provide a platform for concerned interests to constructively critique and to inspire debate while helping to give that debate form, scope, and meaning. The intent is to reform and redirect rather then revolutionize education.

It is important to point out that the study reveals a multitude of other areas of concern which could be the subject of other studies. Fragmentation of the problem is unavoidable, but the conduct of the study was designed to resist the temptation to follow each of the myriad of associated problems to the final end. This was done to keep the project moving along so that the original purpose could be realized. For this reason, little reference is made to many significant developments in educational delivery techniques such as the use of computers, technological aids, and others. Influential factors were acknowledged and their trend indications considered. The use of this procedure avoided the serious pitfall of endlessness and resulted in a timely conclusion.

Since the developed relationships are relative rather than absolute, the representation is intended to clarify thought, not provide an ideal model to be defended as perfect. Also, this curriculum and course development reflects an attempt to incorporate several innovative ideas for change called for in many previous studies. Many of the ideas, conclusions, and recommendations in this report are not too different from those of other studies on engineering education.

It is recognized that if imaginative changes are to be accomplished in an orderly and sound manner, the ideas and energies of the entire academic community must become involved for the prosperity of all concerned. It is hoped that this study will be a significant contribution toward this end and may become the subject of review, debate, and constructive revision.

CHAPTER II

THE PROFESSIONAL SETTING

INTRODUCTION

This chapter considers the historical questions of the field of civil/sanitary/environmental engineering; where has the profession been and where is it now? This is not simply a didactic exercise but strives to glean certain engineering education principles, trends, or conclusions which may influence the development of curricula and courses in environmental systems. This discussion includes a review of engineering education conferences, curricula in use, educational methods, the employment base, future engineering roles, and new directions for technology.

Societal Influences

The history of western civilization reveals the continuing struggle to ease the burdens of survival. The ancient battle has been waged through the application of the intuitive wisdom of the people to develop methods to provide for man's basic needs and to produce some luxuries of life (McGauhey).

Some degree of modification of the biosphere evolved with the earliest man when he began to aggregate populations at water and food sources (Roberts). Nature's ability to assimilate the residuals of man's presence was not overly taxed because the numbers of people were small. The population growth rate is perhaps the crux of the spectrum of problems associated with conservation or the rational use of the environment to achieve the highest quality of living for mankind (Dasmann). Man's activities in making a living and enjoying life consume the elements of the biosphere and, as the population increases, the use and abuse of these resources also increases. Until very recently, the rate of population growth over the millenniums increased very slowly. In fact, the rate of population increase did not reach .17% per year until the late 17th century. The acceleration of world population growth was particularly pronounced in countries that were the most highly developed. The growth was the product of the decline in the death rates, prolonged over three centuries, and the lag in the parallel decline in birth rates. Since that time, the population has increased at an increasing rate; at present, the rate is slightly above 2% per year, which means that total population "doubling time" dropped from 1000 years in 1650 A.D. to less than 35 years in 1970 A.D. Also, the number being doubled is obviously larger each year. Projection of this type growth into the future produces a world population larger than the most optimistic estimates of the planet's carrying capacity (Freedman).

People today are demanding more from the biosphere, and this increasingly affects all plant and animal life on earth by altering ecological balances. Man's methods of using land, water, and air as waste disposal sinks have impaired their quality so drastically that these elements are no longer usable, in some instances, for his own needs and purposes (Chanlett). The stage is set on the one hand with the huge resource demand of an ever increasing population and on the other with diminishing available non-renewable resources coupled with increasing pollution of the biosphere.

An environmental awareness that something was wrong began to be manifested in the middle 1800's with the appearance of studies which identified a concern for the relationship of the environmental situation and the status of human health (Purdom). An even earlier awareness was indicated in 1600 when sulfur dioxide was the first chemical to be specifically recognized as an air pollutant (Hesketh).

It was not until the 1960's and 1970's that the American people became aware of their environment and "discovered" ecology. Evidences were plentiful: the growing smog, the smaze enveloping the mountains, the diminishing numbers of fish and wildlife, and the raw effluents being pumped into lakes and streams. The cry went out to "do something". All aspects of the environment needed attention, and the people demanded action. The collision of uncontrolled economic growth and environmental concern was heard around the world (Roberts).

Historical Activities of the Sanitary Engineer

Essentially, civil engineers have been engaged in designing and building the sewers and water works to improve the sanitary conditions of urban areas. The early civil-sanitary engineering activities only included the fields of water supply, sewage disposal, and stream pollution which were the concerns addressed by basic civil or chemical engineering. These activities, however, did not remain dormant and experienced a gradual and substantial lateral expansion into housing, milk and food, vector control, and air pollution. Educators and public health officials reported in 1924, 1929, and 1939 on the then current practices in sanitary engineering and traced its expansion to numbers of schools of engineering and public health (Reid). Following World War II, sanitary engineering was taught as an offshoot of civil engineering and in public health schools as public health engineering. During the late 1940's, sanitary engineering education continued to expand to include industrial hygiene (e.g., Reid at Georgia Tech), infusion of sanitary engineering into the training of all engineering (Reid in 1947), and field training (Sheppard, Tisdale, and Reid, 1948).

In October 1943, the term "Sanitary Engineering" was defined by the Committee on Sanitary Engineering of the National Research Council, and for the first time the environmental facets of the sanitary engineer appeared on the sanitarian's list of responsibilities. The base of activities of the sanitary engineer, as defined by the Sanitary Engineering Committee, Civil Engineering Division, American Society for Engineering Education in its report of June 22, 1949, was considered too broad for an undergraduate course of study for all branches of the field. It was suggested, therefore, that a sanitary engineering educational program should consist of: a four-year program leading to a B.S. degree in engineering, preferable with a sanitary option; and a fifth year of study leading to an M.S. degree in a specialized field. References were made regarding the advantages of field training, discussions of operational problems, and opportunities to develop the student's abilities in public speaking and report writing (Reid).

By tracing the trends of educational developments, the activities of the sanitary engineer can be followed rather accurately since educational programs normally mirror the activities and demands of the professional practitioner in government and industry, although a time lag is usually evident. (Educational offerings usually lag needs.) Engineers engaged in the various engineering activities in the 1950's referred to themselves as public health engineers or sanitary engineers, and in some special areas they used such titles as industrial hygiene engineers or air pollution control engineers. There was an identification problem since the title "sanitary engineer" was not mutually accepted by most of the mechanical engineers, chemical engineers, public health engineers, or other professionals engaged in activities generally defined as sanitary engineering. In 1955, the American Sanitary Engineering Intersociety Board (ASEIB) was incorporated but met with limited acceptance. In 1966, the name was changed to Environmental Engineering Intersociety Board, and in 1973 a merger produced the surviving designation, the American Academy of Environmental Engineers (AAEE). Even so, the membership is composed mostly of engineers concerned with water quality, but other representative professional areas have since become more numerous. In December 1963, professors in the universities formed their own organization to develop and present their views on environmental education, the American Association of Professors in Sanitary Engineering, which changed its name in 1973 to the Association of Environmental Engineering Professors (AEEP).

Formal sanitary engineering education programs appeared in 1890 at the Massachusetts Institute of Technology (Sedgwick), while graduate programs first appeared at Harvard University (Whipple) in 1911. Harvard also produced the first doctorate study in 1927 (Baity).

REVIEW OF CONFERENCES

With the expansion of activities of the sanitary engineer, a corresponding concern for the quality of education in the environmental field prompted the sponsorship of a series of national conferences in an attempt to suggest appropriate and adequate curricula to meet societal needs and establish some organization and guidance for educational efforts and programs. The basic purpose of the conferences, as stated at the 1967 conference, is to provide a forum for engineers to examine the "adequacy and requirements of the educational programs serving environmental engineering."

<u>1960 Conference, Harvard University, Cambridge, Massachusetts</u>

In 1960, the ASEIB sponsored a "Study Conference on the Graduate Education of Sanitary Engineers" at Harvard University, which was co-sponsored by the Massachusetts Institute of Technology and National Science Foundation. Some resolutions and conclusions from this conference reflect the policies and struggles of the times. The terminology dilemma was referred again to the ASEIB and it was suggested "that every possible effort be made to reconcile differences in the use and understanding of terminology designating the field so that a mutually acceptable engineering title of common usage be established." Because of the growing diversity of sanitary engineering concerns and the difficulty in obtaining adequate preparation in a specified time period, "...it was resolved that the time length of graduate instruction or continuation study for the first degree in sanitary engineering and environmental health be one calendar year rather than an academic year." Common core courses were identified, and the thesis requirement remained an option of the institution. Collaboration among schools was encouraged. The ASEIB was urged to endorse the accreditation by ECPD of graduate programs in sanitary engineering beginning with Masters programs. Specific course requirements and electives were suggested in each of the reports of committees on Water Resources Engineering, Air Resource Engineering, and Public Health Engineering. This division is significant of the practice of the functional shred-out of environmental engineering education.

1967 Conference, Northwestern University, Evanston, Illinois

A joint sponsorship (EEIB & AAPSE) convened the Second National Conference on Environmental and Sanitary Engineering Graduate Education in 1967. In this conference, the concept that the fifth year of study leading to the Masters Degree should be the first professional degree for environmental engineering was reinforced. The conference also made an effort to resolve the title dilemma by stating that the term "environmental" was a "generic term covering the specialty area of sanitary engineering as well as the engineering aspects of air, industrial hygiene, and radiation management." Environmental Engineering was gradually becoming accepted. The conference also addressed engineering preparation for non-engineering students in environmental programs.

1973 Conference, Drexel University, Philadelphia, Pennsylvania

Since it was recognized that the scope and dimension of environmental engineering problems had changed sufficiently to warrant another re-examination of educational programs, the Third National Environmental Engineering Education Conference was convened under the sponsorship of EPA, AAEE, and AEEP in 1973. Such a review was considered necessary to determine if environmental engineers were being adequately prepared to meet the challenges ahead. Without delving into too many details about the conference, a review of some recommendations will provide an insight as to the perceived structure of environmental engineering programs. They constitute a "jumping off" point for this study. (Purdom)

1. The Masters Degree in one of the major professional fields of environmental engineering is highly desirable for the majority of those who will practice environmental engineering. (This is essentially a re-affirmation of the previous conference.)

2. A thesis, or equivalent individual study activity at the Masters level, should be encouraged.

3. Graduate curricula need to be flexible to provide in-depth education for the specialist and broad preparation for the generalist.

4. Interdisciplinary education should be emphasized.

5. Education in a given field, such as engineering and/or the sciences, should be established before broadening into major professional fields such as water quality or air quality engineering. Well-grounded specialists with interests in the overall environmental area should be encouraged to broaden their scope of endeavor toward becoming environmental managers, planners, or generalists.

6. Federal support should be provided for graduate education in environmental engineering, and state legislatures should be urged to support environmental engineering. (This was recommended because it is to the public benefit and not a typical competitive industry.)

7. The development of undergraduate environmental engineering education should be encouraged either through distinct programs or through inter-departmental programs. Curricular requirements should be developed to meet the criteria for ECPD accreditation and to allow smooth transition of graduates into advanced degree programs.

8. Specialization in any specific aspect of environmental engineering should be through advanced degree education or on-the-job training.

9. Environmental engineering courses should be available to all

engineering students. A general course should be developed by the environmental engineering faculty.

Other Annual Conferences

The American Society for Engineering Education (ASEE) has conducted annual conferences which provide a platform for the exchange of ideas and concepts relative to all fields of engineering. The society magazine Engineering Education is published monthly from October through May. Abstracts of papers presented at each annual conference are published as well as complete papers on selected subjects. The expressed views are those of leaders in their respective fields throughout the country. The ASEE 81st Annual Conference was conducted June 25-28, 1973 at Iowa State University; the 82nd Annual Conference was conducted June 17-20, 1974 at Rensselaer Polytechnic Institute, Troy, New York; and the 83rd Annual Conference was conducted June 1-3, 1975 at Colorado State University.

The Institute of Environmental Sciences conducts annual meetings and publishes the proceedings. The 20th meeting was at the Shoreham-Americana Hotel, Washington, D.C., April 28-May 1, 1974. These meetings provide a forum for the presentation of professional papers on a variety of environmental subjects, generally in support of the Institutes' constitution. They do not, however, publish a position summary or recommendations.

During March 5-6, 1973, the Third Annual Environmental Engineering and Science Conference was conducted at the University of Louisville Speed Scientific School under co-sponsorship with the International Association for Pollution Control. Forty-five papers were presented at 10 sessions which constituted a report to the environmental engineering community on the status of present environmental quality problems and the availability of pragmatic solutions to these problems based on professional input from an interdisciplinary and intersocietal viewpoint.

Many other conferences have been conducted indicating that environmental education activities are broadly involved in promoting a pluralistic approach to the problems of society.

CURRICULA IN USE

Basically, societal environmental problems are essentially the same as they always have been, but problem intensity and increasing complexity coupled with expanded public and governmental awareness have dramatically changed during recent years. The corresponding demand for professional roles to solve social-environmental problems have triggered the development of mostly reactive educational programs.

A meaningful summary of the status of graduate curricula in use is very difficult because of the continuous state of change of current programs, the absence of standardization among programs, and the lack of a clear understanding of the meaning and scope of environmental education. This is manifest in the diversity of interests and activities and the fact that these same interests are shared with other professional and scientific disciplines. Tracing and categorizing the available programs is further hindered by a lack of consistent program designations, varying course contents, and the location of the programs (Christman). The general form of most graduate programs can be ascertained by reference to such documents as the 1975 Annual Guide to Graduate Study published by Peterson's Guides, Inc., Princeton, NJ, and the Register of Environmental Engineering Graduate Programs, sponsored by the AEEP, AAEE, and EPA. Detailed knowledge about program content, however, is unclear along with the absence of any description of analytical justification or structure of programs.

There has been a significant increase in the environmental course offerings since the late 1950's. A marked increase of acceptable programs in environmental-sanitary engineering was brought about by the Water Pollution Control Act of 1956 which started graduate training about 1960-1961. In 1960, only 23 M.S. and 3 Ph.D. degrees were awarded in the U.S. Federal support increased this number dramatically over the next 10-12 years. In 1960 and 1962, a course summary entitled: "Sanitary Engineering Education Directory" was prepared by the Committee on Sanitary Engineering Education of ASEIB. Because the 1960's brought rapid changes in the profession, the Board of Directors of the American Association of Professors in Sanitary Engineering authorized an educational study and evaluation in early 1966. The Environmental Engineering Intersociety Board (formerly ASEIB) was asked to participate in the development of a "Register of Graduate Programs in the Field of Sanitary Engineering Education." When compiling the first edition of the register, it was agreed that updating about every two years would be necessary, and a second edition was published in June, 1969 (Kaufman). An evaluation of the 1969 register, "An Evaluation of Sanitary Engineering Education" by W.J. Kaufman and E.J. Middlebrooks, was published in January, 1970. (Middlebrooks also has completed an evaluation of the 1974 Register.)

An insight into the overall picture is presented by the sub-committee on "Educational Needs for Graduate Programs in Environmental Engineering" for the Third National Environmental Engineering Education Conference, chaired by G.P. Hanna of the University of Nebraska. This subcommittee presented some 1973 information based on surveys and polls taken from several representative universities relative to their environmental engineering programs. In an effort to bring some organ-ization to an almost unmanageable and lengthy list of environmental interests, the committee tried to focus on important functional areas by first distinguishing three domains of environmental engineering: major professional fields, specialty areas, and other areas of environmental concern (Figure II-1). The major professional fields were designated as: Air Quality, Water Quality, Industrial Hygiene, and Solid Wastes Management, each fitting the general criteria of an established body of knowledge involving quantitative measurements and design characteristics that constitute an engineering curriculum. Specialty areas were iden-tified as peripheral to the major professional fields, independent but supportive of environmental engineering. The other areas of concern were activities which cause and mitigate environmental programs. This division allowed a limited categorical suggested curricula analysis as shown in Tables II-1 through II-5. These suggested programs deal with the results of the environmental problem, not the cause, and therefore do not contribute to the solution of the national environmental problem which is, of course, eventually dependent on the ultimate reduction of demand for non-renewable, limited resources.

Although current curricula data in concise and usable format

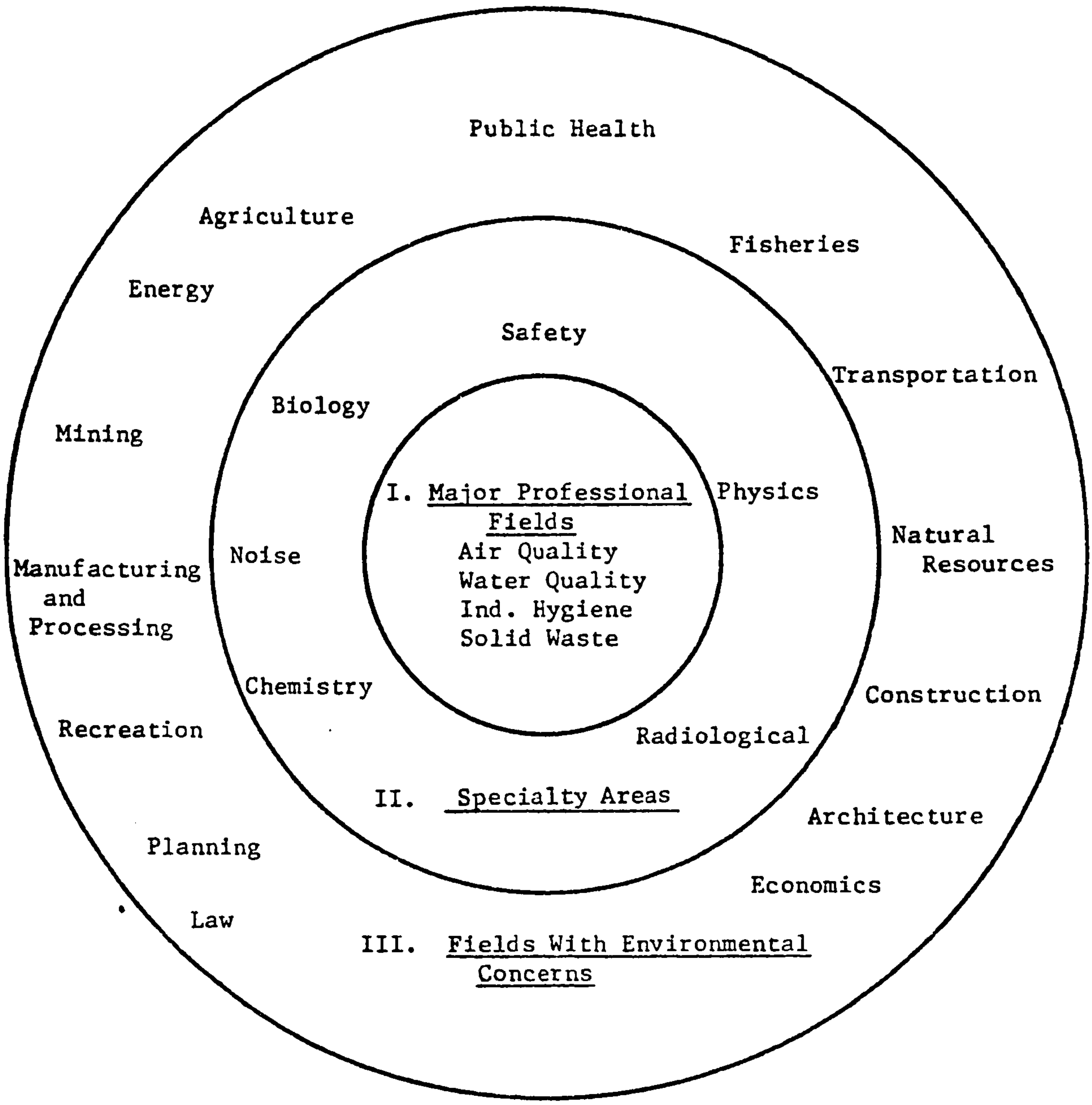


Figure II-1, THE DOMAINS OF ENVIRONMENTAL ENGINEERING (Purdom:117).

Subject Area	Range %	Average %
Engineering		
General Water Quality	2-10	5.8
Water Treatment	2- 8	5.4
Wastewater Treatment	3-16	8.4
Process Laboratory	0-12	2.8
Design	0-11	3.8
Systems Analysis	0- 9	3.5
Hydrology, Water Supply and Sewerage	0-13	3.4
Public Health		
Sanitation	0- 7	2.1
Epidemiology, Physiology, etc.	0- 3	1.0
Chemistry	5-24	12.2
Biology	0-14	5.4
Solid Waste Management	0- 3	0.6
Air Quality Engineering	0- 6	3.5
Research	0-29	8.1
Seminars	0-10	2.6
Other	5-50	31.4
Total Average %		100.0

Table II-1, CURRICULUM, WATER QUALITY ENGINEERING (Purdom).

Area	% Emphasis	Content
Engineering	25	Air Pollution Dynamics, Source Factors, Control Systems, Air Resource Management, Water and Waste Management.
Chemistry	10	Chemistry of Pollutants, Sampling and Analysis, Photochemistry.
Biology	10	Cell and Human Biology, Effects on Vegetation, Animals and Humans, Air Microbiology.
Physics	10	Aerosol Science and Technology, Optical Properties Atmospheric Aerosols.
Meteorology	10	Properties and Dynamics of Atmosphere, Atmospheric Transport and Diffusion.
Applied Mathematics	10	Statistics, Computer Programming.
Environmental Health	10	Elements of Physiology, Toxicology and Epidemiology, History and Organization of Public Health and Sanitary Engineering, Current Environmental Health Issues and Problems.
Social Sciences	15	Air Resource Management, Electives in Law, Economics, Business, Urban Planning.

Table II-2, CURRICULUM, AIR QUALITY ENGINEERING (Purdom).

A Master of Science in Environmental Engineering with particular emphasis on Solid Waste Management is illustrated by the following example:

First Semester:

Resource Recovery The study of natural resources and the means for conserving and re-using them. Present and future availability, alternatives upon depletion, and economics of recycling will be considered.	3 units
Microbiology Basic microbiology of water, air and soil; application of microbiology to the practice of environmental pollution control.	3 units
Environmental Engineering Laboratory Physical, chemical, and biological analysis of water, wastewater, air, solid waste; detailed appraisal of standard analytical methods and the significance of the measured parameter.	3 units
Solid Waste Management Characterization, production, storage, collection, and transport of solid wastes; alternative disposal methods; design principles and environmental impact; management of radiological solid wastes.	3 units
Thesis or Directed Research	2 units
TOTAL	14 units

(Purdom)

Table II-3, CURRICULUM, SOLID WASTE, FIRST SEMESTER

Second Semester:

Environmental Impact Statement The design and conduct of environmental impact studies to meet the requirements for federal and state laws. Case studies and current updating or requirements will be reviewed.	3 units
Physical Processes Principles underlying aeration, filtration, centrifugation, flocculation, sedimentation, adsorption, foaming, distillation, drying, incimeration, pyrolsis, gas scrubbing and particle removal. Advanced waste treatment.	3 units
Chemical and Biological Processes Chemistry of softening, coagulation, disinfection, oxidation, corrosion control, dry and wet combustion and ion exchange. Aerobic and anaerobic processes and the ecology of liquid and solid waste treatment.	3 units
Elective	2 to 3
Thesis or Directed Research	2 units
TOTAL	13 to 14 units

Other specialized work in a solid waste program might include courses in combustion, transportation systems, and in the general area of municipal engineering.

(Purdom)

Table II-4, CURRICULUM, SOLID WASTE, SECOND SEMESTER

A base program for the M.S. degree might consist of some twelve three-hour courses plus practicum or thesis, grouped into the following catagories:

Mathematics (statistics plus one other)	6 Hours
Occupational health	6 hours
Physiology, public health and epidemiology	6 hours
Applied sciences	6 hours
Approved electives	12 hours

A typical thirty-six hour program might include under the above groupings the following twelve three-hour courses:

Biostatistics
Operations Research
Medical Physiology I
Medical Physiology II
Occupational Health I
Occupational Health II
Analytical Methods in Industrial Health
Toxicology
Public Health Engineering
Safety Engineering
Introduction to Audiology
Industrial Hearing Conservation

Table II-5, CURRICULUM, BASE PROGRAM (Purdom).

is scarce, or absent, several generalizations may be made:

1. Studies which lead to the integration of technology and the social components of the application of technology are apparently lacking.
2. Studies which present social concerns and professional responsibilities are few.
3. The use of practical, clinical experience is not widespread.
4. Studies which emphasize interdisciplinology and multi-professional work are few and not always coherant.

These and similar shortcoming were reflected in the findings and recommendations of the World Congress on Educating Engineers for World Development at the Plenary Session at ASEE's 83rd Annual Conference, 1975. These reflect the fundamental needs toward which this study is directed.

New Developments

The recognition of shortcomings of current offerings have resulted in the recent development of new programs, arrangements, and curricula. The programs are too new to be assessable at this time but do indicate undercurrents of significant change.

Carnegie-Mellon University has initiated a new five-year program in technology and the humanities. It attempts to have humanists, social scientists, and engineers jointly explore topics in such technological areas as energy and water resources and in broader areas such as industrialism. The program seeks to develop joint courses, research, and public policy among these groups (Engineering Education).

Dissatisfaction with the classical sort of humanities and social science offerings has become sufficiently widespread that a country-wide movement toward integrating new courses with engineering seems to be occurring. Examples are schools such as Case Western Reserve University that have initiated courses in National Policy Problems and the History of Technology (Hollomon:33).

The University of North Carolina at Charlotte developed a functional departmental arrangement in an effort to encourage innovation, creativity, and interdisciplinary approach by de-emphasizing traditional fields of specialization like mechanical engineering, electrical engineering, and others (Evett).

Cornell University proposed a course in "Environmental Awareness" designed to require the student to function as a member of a multi-disciplinary team, which would aid the student in preparing for the real world. This course would include peripheral topics as communication, economics, mental discipline, enthusiasm, legal and social considerations, ethics, and political implications. Other changes and proposals are under consideration for future implementation such as modification of grading systems (similar to Worcester Polytechnic Institute) and introduction of internships.

Huxley College offers an upper division interdisciplinary program in environmental studies which encompasses all the physical, social, and biological dimensions of environmental problems. Problem-oriented study is stressed and concepts are applied to specific practical situations. The curriculum is based on general areas of study called concentrations. A student is encouraged to focus on the natural or social scientific elements of his specific discipline. The concentrations are: Ecological Systems Analysis; Environmental Planning; Hunger, Food and Malnutriton; Marine Resources; and Population Dynamics. Here again, the emphasis is on interdisciplinary activities, practical application, flexibility, and peripheral environmental concerns (Lukco:3).

Purdue University offers an undergraduate program of inter-disciplinary engineering studies (IDE) which is an effort to bring the unified inter-disciplinary approach where students combine elements of engineering and non-engineering disciplines in such programs as housing and transportation to selected study areas. Students may concentrate on the various elements of environmental engineering or a combination of those elements. The course program is individually developed to permit each student to consider technical alternatives and their various impacts on society and the environment.

Since not all institutions are able, inclined, or prepared to initiate expansive program changes or devote an entire college to environmental concerns, the environmental institute or center concept has been developed which draws on the resources of the university to provide consultation services, educate students, and perform research and information services. These centers attempt to transcend traditional university organizations. Numerous other programs can be singled out to illustrate attempts at significant curriculum changes, such as those at Memphis State University, the University of Virginia, and others.

A brief summary of some of the new directions evident in a cross-section of these programs includes:

1. An interdisciplinary approach to environmental engineering.
2. A trend toward non-engineering and applied scientist joint

training.

3. Inclusion of areas of environmental concerns and their interface with problem solution.

4. Attempts to develop a more practically oriented program.

EDUCATIONAL METHODS

Although studies have shown learning to be independent of methodology, the presentation method employed may greatly influence the setting in which learning occurs and therefore may have a significant effect on student motivation, which does affect student learning. Studies at the University of Oregon have demonstrated that the medium of instruction makes no significant difference in the grades received in a subject, except that two-way TV is less effective (Hollomon:36).

Certain techniques, however, can be employed advantageously by the institution, curriculum planner, and course instructor to promote maximum utilization of available resources, realize educational goals, and match student learning considerations with effective presentation techniques. A single outstanding resource which describes at length many available techniques is Teach-In: Suggestions for Developing College Instruction from the Learning Resource Program, Utah State University, 1972. Several presentation techniques are discussed in Appendix C. Figure II-2 shows how a matrix can be used to match method with desired attributes and goals.

Two especially useful methods are blocking and upside-down curricula. Blocking, or intensive course teaching, is an excellent way to cover a lot of material in a short time span. Academic clock

METHODS	ATTRIBUTES							GOALS										
	Adaptability	In-Depth Study	Survey	Formal Classroom	Applicable to Real Situations	Exposure to Real Situations	Self-paced	Verbal Participation	Outside study	Direct Student-Teacher Contact	Interdiscipli-nary Approach	Competence Oral & Writ. Commun.	Ability to work with others	Material Comprehension	Prob. Analysis & Solution	Ingenuity & Creative Resp.	Independent Study
MLS		X					X		X		X				X		X
Open University			X				X		X					X			X
Lecture (LMI)	X		X	X										X			
Intensive course			X	X						X				X			
Programmed Learning	X		X											X			X
Independent Study	X	X					X		X	X		X					X
Discussion Group	X		X					X	X		X	X	X		X	X	
Seminar	X		X					X	X		X	X			X	X	
Simulation & Role Playing	X				X					X			X		X	X	
Laboratory		X			X									X			
Field Trip					X	X							X				
Film/TV - TAPE	X	X	X		X	X	X							X			
Co-oping					X	X						X	X				
Group Activities						X		X					X				
PIP	X						X		X	X					X	X	X
Auditory-Tutorial Method							X		X	X					X	X	
Inquiry Learning		X					X		X	X		X			X	X	X
Case Study	X				X	X											
Directed Reading	X	X					X		X	X	X	X					
Continuing Education	X				X						X						

Figure II-2, EDUCATIONAL METHODS MATRIX

hours remain constant, but the course is completed in a few days or weeks. This procedure is especially adaptable for intersessions, satellite presentations, and/or continuing education courses. Many graduate level courses lend themselves very well to this technique. However, subjects that require in-depth outside study by the student often require a longer time span to ensure that the student has sufficient time available to work through and assimilate the additional material.

An intensive program may be developed by simple modification of an existing course schedule according to needs. Changes can be made so that a three-hour class is arranged to meet every day or five hours per week. In this way, an entire course can be completed in two-thirds the regular time. This type of course blocking frees the professor to pursue off-campus research and service projects which promote effective classroom instruction. The student also benefits by freeing time to devote to directed readings for remedial work (e.g., independent study) or project work in an area of interest.

The introduction to problem solving and the use of rational techniques begins very early in life by purely "hands-on" confrontation with problems. Likewise, learning major facets of an overall system prior to exposure to in-depth theory may be applied to curricula such as urban systems where the whole system is looked at prior to detailed description and analysis (Reid). This describes the upside-down curricula technique.

In summary, curriculum planners and course instructors should certainly be familiar with the many methods of presentation available and utilize appropriate options according to the local situation. Too often, instructors use only the one method, lecture, and thereby fail to take advantage of varieties of learning environments. Many imaginative and detailed methodologies are continuously being published in journals, especially Engineering Education.

EMPLOYMENT BASE

The Engineering Manpower Commission of Engineers Joint Council, November, 1975, indicates that the employment prospects for engineering graduates are closely related to the state of the national economy and the priorities assigned to problems of national concern. Although government economists profer signs of economic recovery in the last half of 1975 and early 1976, they are not in general agreement as to the extent or rate of continuing recovery. There are obviously many national problems requiring the services of engineers for solutions. However, long-range national goals and programs need to be, but have not been, conceptualized or developed in many areas.

Nevertheless, certain factors remain fairly clear. The technological component of society will remain high and become increasingly complex, and the need for a substantial proportion of technically educated people will remain high or even increase. No indication appears on the horizon for a return to a simpler lifestyle or economy, and the engineer will continue to play a leading role in society's technical advancement and application. Momentary decreased technical manpower requirements in one area may be offset by increased requirements in other areas. Shifts will probably occur in related areas such as environment and energy.

National statistics by the Department of Labor and the Bureau of Census are extremely difficult to interpret due primarily to the broad spectrum of occupations visualized as engineering. The total engineering stock is much greater than just numbers of engineering graduates (Hollomon:12). Recent surveys regarding environmental occupations indicate that a large percentage of all employees consider themselves as some form of environmentalists (Adams).

Engineering related to environmental concerns is a very large profession spread over a diverse base. The U.S. Department of Labor has estimated that an average of 48,000 engineering openings per year from 1974 to 1980 will be created by normal attrition factors alone, and almost as many more openings will be created by expected growth in overall engineering employment. The mere size of the profession carries with it a large, built-in demand for new engineers. The involvement of engineers in widespread sectors of employment provides a degree of security since no single industry or activity accounts for a disproportionate percent of total engineering employment and therefore major disruptions are not likely. Placement statistics leave little doubt that in a period of recession, an engineering degree will be a definite advantage in finding employment.

The increasing technological complexity of modern society offers both opportunities and challenges to engineering graduates of the next decade. Major problems need attention but cannot be solved by people with little or no understanding of science and technology. By the same token, engineers are being increasingly called on to concern themselves with the social, economic, political, and moral aspects of technology, thus broadening the role of the engineer.

With the need for engineering talent increasing and the number of graduates remaining level or decreasing, the employment picture in the coming decade appears bright for almost any area of engineering interest and especially in employment sectors facing new limitations relative to pollution, consumer protection laws, and the rising costs of materials and energy.

Career Ladders

The work and career of graduates change significantly over time. Studies indicate a shift after graduation from technical activities to an increasingly managerial emphasis within a few years (see Report of the Committee on Goals of Engineering Education, ASEE). Some of the reasons for this shift are personal growth, requirements of employers, changing national economy, etc. Of engineering graduates, 87% of those receiving a B.S. degree remain engineers, 74% of those with M.S. degrees remain engineers, and only 65% of those with doctorates remain engineers. The educational experience should prepare the student for these possible shifts and try to develop a capacity for self-learning so that he may take advantage of a changing career in terms of personal fulfillment.

As our industrial economy proliferates, all engineers have and will be required to face the disruptive effects of industrial processes on the environment. As these negative effects tend to compound themselves in a limited environment that can only absorb a finite amount, solution and prediction of these problems will be essential.

Demand for engineers will continue to shift away from employment in durable goods, construction, and manufacturing processes. A significant increase of engineers employed in information and people- and service-related activities, including planning functions, will reflect the general employment trend in the economy as a whole. Government will absorb only a fraction of engineers seeking employment; most will enter the private sector. Those who do find employment in government will find jobs more available at the state level, and job categories will deal mainly with planning and control functions.

For engineers as a whole, fewer as a group will remain in pure engineering as the number of years on the job increases. Employment functions for engineers according to the Engineers Joint Council show 20% of engineers employed in planning and management functions, 18% in design, 11% in advising and consulting, and the rest in R&D, sales, production, etc. This trend indicates a shift away from application of technical skills and into an increased management/leadership role. This shift is marked by an obsolescence of the management-oriented engineer in technical knowledge. Technical ability is maintained, to a marked degree, by the level of technical responsibility and engineer retains. This increase of administrative function and the need to establish leadership require a more interpersonal approach by the engineer. This is a clear calling for a broadened educational background in humanities to provide more understanding by the engineer of human-oriented problems in addition to practical knowledge of technical applications.

ENGINEERING ROLES

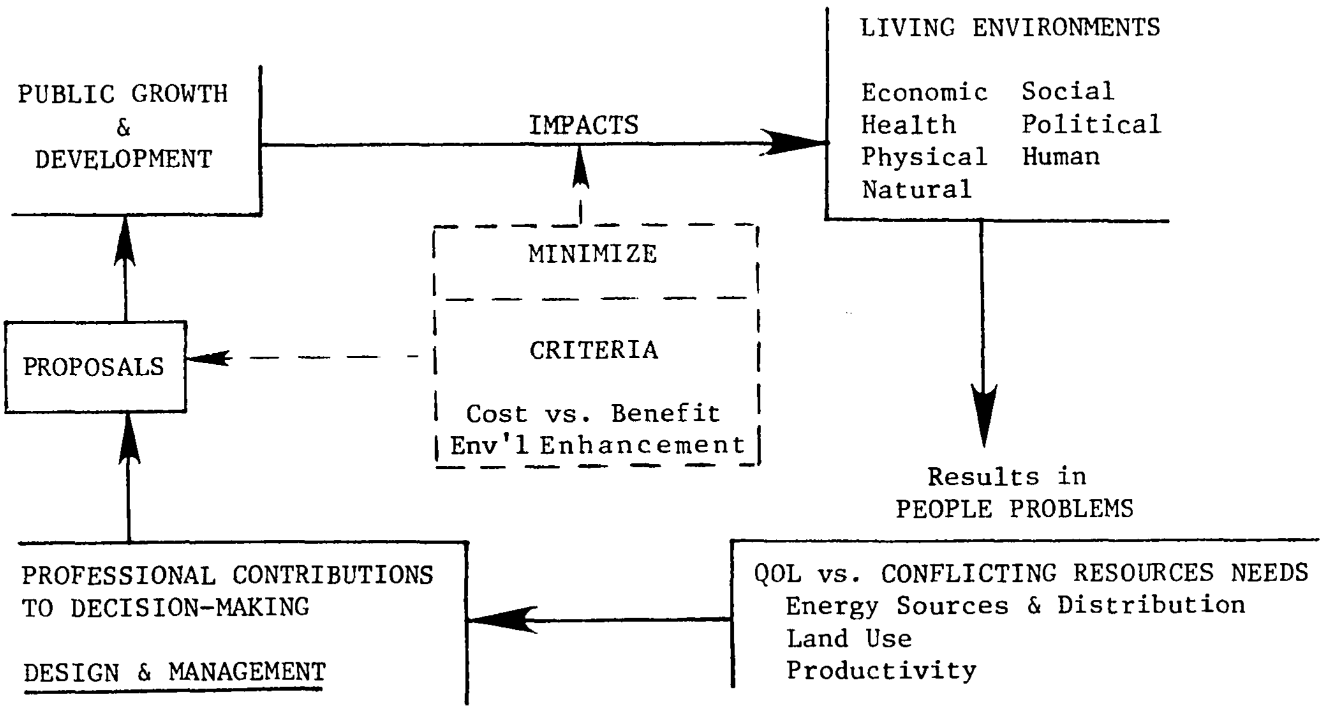
Engineers are engaged in two basically different types of activity. One is the design and synthesis of useful objects, processes, or systems. The second is the discovery and accumulation of goal-oriented scientific knowledge needed for present or future designs (Hollomom:39). These may be further divided into the two areas of design, large and unit systems, and management and control. (Figure II-3)

Future Tasks

The future work of the engineer, as the focal point addressed by a curriculum, involves responsibility in two areas. One is a technical specialty, and the other is the use of technology toward the betterment of mankind, or technical responsibility.

The technical specialty role involves coping with the problems of society in an engineering sense which is embodied in the systems approach defined as evaluation, synthesis, design, and implementation. The professional of the future will have to have the capability to handle complex social and economic considerations as well as demonstrating competency in a rapidly changing technical field. He must have breadth in his background to grasp the social and economic forces that influence and are incluenced by his technology. The engineer must be able to integrate the rapid rate of complex technological advances into an interdisciplinary approach to problem solving. Example future areas of environmental concern, against which a graduate may interface, were tentatively suggested by Flinn and Reimers of Battelle Columbus Laboratories as: (Flinn)

1. Impacts of New Energy Initiatives.
2. Geophysical Modifications of the Earth.
3. Trace Elements (Metal Contaminants).
4. Proliferating Hazardous and Toxic Chemicals.
5. Emissions from New Automobile Fuels, Additives and Control Devices.



Engineering pertaining to environmental systems may be described as the art of applying scientific and technological knowledge to natural and man-made surroundings to the total human environment for the promotion and protection of the health, welfare, and well-being of mankind.

National policty indicates a desire to regulate development and use of technology to control people problems by minimizing impacts on life environments through the technique of requiring certain criteria be considered early in the design phase for both new programs and for solutions to in-place unbalances. These criteria include an assessment of consequences vs. benefits, environmental and economic goals vs. societal goals; and environmental enhancement through the use of cross-impact analysis methodology.

These considerations require an expanded conceptualization of environmental professional activities including a recognition and consideration of value systems other than technology.

Figure II-3, ENVIRONMENTAL PROFESSIONAL IDENTITY

6. Disposal of Waste Sludges, Liquids, and Solid Residues.
7. Critical Radiation Problems.
8. Fine Particulates.
9. Expanded Drinking Water Contamination.
10. Irrigation (Impoundment) Practices.

The engineering roles may also be applied to an increasing sector of software, service producing functions, or socially oriented systems. This may lead to more involvement in the decision-making processes in an interdisciplinary fashion on multi-professional levels.

The second role of the engineer encompasses great professional responsibility. The future holds much promise for positive advances in the level of human existence, but it also holds a potential for disaster. The differences between the two, and the tradeoffs and compromises made, promise to hold the key to the successful survival of mankind; i.e., in harmony with the earth's natural balance, living as part of nature's scheme and not in spite of it. Technical applications and innovations demand political, social, economic, ecological, and moral evaluation in conjunction with the systems approach and in advance of decision (see Appendix B). Such evaluation requires formulation of values in the light of life goals, clarification of fundamental convictions, and concepts of work (sometimes referred to as meta-values). Technical responsibility also implies an effort to regain harmony with natural systems and calls for creativity and sensitivity to bear in learning how to design with nature (Milton). Responsibilities relative to human survival, Professional directions, and individual actions are tied to the intellectual, social, and psychological growth of the students.

According to Schumacher, a meta-physical foundation transcends divergent opposites such as:

local benefit	vs	benefits to humanity
short-term benefit	vs	long-term disbenefits
physical needs	vs	social needs
pollution control	vs	economic disbenefits
progress	vs	too much technology

The future work of the engineer will probably increasingly require the integration of technology and the humanistic use of technology. (Appendix B) The curriculum should provide for this pattern.

REDIRECTING TECHNOLOGY

Introduction

If modern life can be described as in a state of continuous crisis, it might be appropriate to suggest that something may be wrong with modern education. As a cornerstone of society, education remains the central agency for human development. The heritage of our educational system, in terms of organization and content, has been one of reductionism, separation, and division. The development of society cannot help but have mirrored this characteristic since decisions which have served to help form our society have been carved out by highly educated people and reflect their values. In other words, the sum of individual and collective decisions have been made against a system of values which describe our culture.

The goals (or ends) of education, that of understanding the present world, apparently have been lost in the means of reductionism. The missing ingredient of education seems to be a mechanism to provide an integrative focus or unifying process which gives direction and meaning to education. Previous attempts at integrating knowledge and increasing learning capacity have concentrated primarily on modifying external aspects of teaching processes such as classroom scheduling, teaching styles, methods of presenting material, and physical school design. Many important changes, innovations, and improvements have been realized, yet the billions of dollars spent in recent years on education appears to indicate that lasting solutions have not yet been articulated. Perhaps solutions to the problems of education (and modern life) cannot be found in organization, administration, or the expenditure of money but rather, as Schumacher and others have suggested, within each individual in terms of values, life goals, and concepts of work.

It is suggested that a mechanism to accomplish an integration of education may be through humanistic studies leading to a concept of a higher sense of responsibility. The precise definition of such a concept may be very difficult, if not impossible, to articulate in the fashion of academic tradition, but simply means applying different measuring scales of responsibility against the scope of professional activities. It is envisioned to encompass a desire to re-evaluate and redirect science and technology according to a priority alignment based on timely human needs and basic human survival. This re-orientation is manifest in the application of an expanded set of considerations indicated by scientific feasibility versus social need versus economic feasibility versus effects on human survival in terms of future generations, social tasks, political tasks, and others. This effort receives its impetus from an attempt to bridge the gulf of incomprehension between the historic bipolarization of the humanities and the sciences.

Grasping an expanded sense of responsibility requires going beyond the values transmitted through the traditional formal education process, which is the point where the difficulty of definition and curriculum application arises. How can a graduate be expected to measure the conduct of his activities against a value system he may be alien to, has not been exposed to, or is unable to comprehend? It is suggested that perhaps this can be accomplished by presenting humanistic studies designed to increase the student's awareness of differing values, basic convictions, and goals of technology.

A higher sense of responsibility may be visualized as a scheme of ideas or "things" which, when taken in the aggregate, enables one to gain a larger perspective and break the bondage of parochial values, attitudes, and learned measures of conduct. Like the Quality of Life concept, if someone were asked to express the content of this aggregate, cohort responses would be varied, confusing, and inconsistent. By no means does this suggest that it is hopeless to attempt to describe the concept of a higher sense of responsibility in a manner that has some meaning within the scope of professional actions. Rather, it implies that some effort is required to disentangle the various components of a concept to the point where it may have decision-making relevance.

With this goal in mind, one of the first tasks of this training program is to provide a platform for expanding the scope and range of ideas and values, then to devise a mechanism for systematically incorporating elements of a concept of responsibility into the curriculum through the identification of a sub-set of explanatory indicators. Since this attempt is a pioneering and exploratory endeavor, it would also provide an insight as to what additional research and investigation is needed to further refine and develop curricula and course contents.

Concepts of Values

As E. F. Schumacher stated (page 75), "The essence of education ... is the transmission of values. . ." In professional education, this is partially accomplished via the media of technical language representing specific ideas, tools, and concepts in combination with specialized "know-how." This combination forms a specific technical value system. Because professional educational systems have been routinely characterized by rigid structure, reductionism, and compartmentalization, the graduate of such an experience incorporates a peculiar set of narrow specialized ideas according to that formal educational experience into those preconceived values brought into the educational setting. (The question of the depth, bigness, or universality of values transmitted by the educational experience remains to be determined.) For instance, the typical professional student (in the sciences, medicine, law, engineering, military, or whatever) is subjected to and expected to master a professional language, analytical tools, and appropriate cognitive data specific to his specialty. This information collectively constitutes the essence and structure of a professional value system which is used by the graduate as a measuring device to evaluate and govern his actions and thoughts which make the world intelligible to him. When confronted with a problem in the real world, an individual brings to the problem envelope his own particular set of values, attitudes, and ideas which have meaning to him. It naturally follows that his contributions cannot be anything other than a reflection of and conformity to these values. Any other solution is inconceivable and unintelligible to him.

This may describe the contribution of higher education and is visible in contemporary society. Responsive resolutions to the symptoms of the problems of society (and education) have been many and varied and are generally characterized by stop-gap measures such as crisis management and incrementalism in decision. One popular hue and cry has been the attempt to apply a comprehensive interdisciplinary systems approach on a wide range of environmental problems. (Sometimes described as "harnessing genius", C&EN November 29, 1971, page 36.) The intent is to try to dilute the specialized "tunnel vision" effect by spreading the problem over several disciplines in the hope that the study outcome will reflect at least more than one set of prejudicial values. Opinions are mixed as to the appropriateness and success of this technique. Serious structural and organizational conflicts within the university environment are counterproductive to the spirit and letter of interdisciplinology. In addition, the process is so contrary to each participant's values, concepts, and traditions that the question of how to get people to work together successfully in an interdisciplinary fashion is the current subject of a great deal of investigation and research.

Another symptomatic educational response has been to train specialists in environmental problems. The functions of this "new breed" of professionals are to resolve environmentally related problems and to advise industry on mitigating strategies associated with and the result of the ever onward advance of science and technology. The fallacy of this approach is pointed out by Russell F. Christman in his paper, "Graduate Education and Environmental Studies" presented to the symposium on Learning for Survival in Spokane, WA, October 1974. These responses and many others are commonly characterized by the fact that they confront only the symptoms of the predicament and not the basic underlying cause.

Even though the formal educational process functions primarily as a transmitter of values, rarely, if ever, is a value system recognized, articulated, or even remotely considered as an integral part of curriculum design. Even the simple recognition of this critical function would be a giant step forward because this would force a careful consideration and delineation of the values transmitted and also, perhaps, the values that are transmitted by the absence of certain information and ideas.

It is suggested that the cause of some of the problems of society are at least partially attributable to a consistent misalignment of values as presented through higher and professional education. Educational systems need to expand and define values by the introduction of relevant studies leading to a clarification of fundamental convictions. It is again suggested that this may be promoted by the infusion of a concept of a higher sense of professional responsibility as outlined herein.

Sense of Purpose

A higher sense of professional responsibility also involves an expanded sense of purpose or knowing how to order priorities for human betterment. In retrospect, multiple glaring examples in the business and industrial arena evidence the absence or misdirection of such a concern. The singular criteria of the profit motive and the "almighty dollar" seems to have been the dominant justification and motivation of commercial activity for many years. Perhaps industrial concerns rest with not what is produced, but primarily only with what the industry may gain from what it produces. Many industries apparently have consistently minimized considering any aspect of the consequences of their actions in any terms other than salability and profit. (The occasional voice in the woods challenging materialism, calling for restraint, and pleading for a different order of priorities, has not been adequately heard or seriously considered.) It seems as though very clever advertising campaigns are designed to tell the people what they want and need, while the industry marvelously responds to those "needs" at just the right moment. (Adult education and the transmission of values through the media of television advertisements and programming is an extremely powerful influence and is becoming the subject of controversy and careful scrutiny.) Only recently has the profit motivation been challenged by concerned people who demand a different and higher sense of purpose, such as consideration for items of vehicle safety, passenger safety, conservation of resources both in construction and operation, and control of harmful pollution, to name just a few. An industry-wide commitment to change merely to stay alive is dictated by a perception of what is possible to build and sell rather than of what needs to be built.

The auto, railroad, and aircraft industries seemingly never fully visualize themselves as problem solvers in the larger area of transportation needs relative to human needs and survival. (A similar situation in the aircraft industry regarding change is described by Warren E. Kraemer in his article, "The High-Technology Trap: Too Much Too Soon", in Dealing With Technological Change, page 19.)

Many examples reflecting a value system distorted by the omission of the larger concerns of human needs may be found almost anywhere one might be inclined to look: the sulphur oxide emitting power plant which threatens to close down operations rather than attempt to comply with federal clean air standards (eastern Oklahoma 1976); the real-estate interests that build on known geological faults (central and southern California 1960's); and the copper smelter, while emitting tons of SO_x into the atmosphere, rates its economic contribution (payroll) to the community above all other considerations of health and human welfare (Utah 1973).

The commonality of these cases is that some sort of genuine human or societal need existed at some time and was the basis for justifying the means to satisfy that need. However, the ingenious application of sophisticated technology was narrowly directed to satisfying only one aspect of the problem while suppressing or neglecting essential requirements of the larger social system.

Nevertheless, to rigidly maintain the extreme position of a blanket radical critique of industrial society as corrupt, dehumanizing, and self-destructive is as equally inappropriate and fallible as the extreme of raising the banner of ecology, conservation, and the environment above all other considerations. Significant progress is being made on a sane, reasonable and balanced approach of science and technology against other societal priorities. The engineer will be called on to exercise the balanced approach necessitating an understanding and realignment of values, priorities, and goals. In other words, science and technology, in order to serve humanity, must understand and consciously relate to the basic convictions and views on the meaning and purpose of life of the society it intends to serve. The need is for a revision of the ends which the means are meant to serve (Schumacher).

The Mount Carmel Declaration document drafted by an International Symposium held in Haifa, Israel, December 1974, calls for greater responsibility on the part of technologists and urges that every technological undertaking must respect basic human rights and cherish human dignity (Appendix B). Also, technology must not gamble with human survival. As pointed out by Alvin M. Weinberg, Director of the Institute for Energy Analysis at Oak Ridge Associated Universities, the problem is that much of technology required for human survival, in some sense, gambles with human survival. Perhaps this dilemma is an example of the situation described by G.N.M. Tyrell as a "divergent" problem which cannot be solved by logical reasoning in the ordinary sense but demands transcending forces from a higher level (Schumacher:90).

Confrontation with the dilemma of overcoming or reconciling divergent opposites is certainly not within the scope of this study. It is suggested, however, that the curricula and courses developed herein will help illuminate some elemental components or scheme of things which may contribute to the concept of a higher sense of professional responsibility through a better understanding of basic convictions.

Engineering pertaining to environmental systems may be described as the art of applying scientific and technological knowledge to natural and man-made surroundings to the total human environment for the promotion and protection of the health, welfare, and well-being of mankind.

CHAPTER III

THE EDUCATIONAL SETTING

INTRODUCTION

In preparation for an analysis of the educational scene in the context of a training program at the Masters Degree level, an extensive survey and review of current literature was undertaken in search for trends, proposals, criticisms, curriculum innovations, institutional arrangements--anything that might provide an insight into the development of a program of the highest caliber and that also might be the basis for a significant contribution to graduate education. Even though the quantity of literature proved to be truly massive, the greater portion seemed to indicate a minimum of a clear understanding of the extent and complexity of the problems of higher education and the implications of viable solutions. Perhaps the mood of undiluted skepticism prevalent in the 1960's and early 1970's forced concentration on the inconsequential while ignoring (or at least suppressing) the permanent and valuable, the result being that educational ends were sometimes obscured by an overwhelming emphasis on means and perhaps heavily influenced by directions of fiscal support.

Nevertheless, a number of appropriate references were assembled which address higher and graduate education and suggest new study orientations. Some references served as a valuable core of research literature on which a part of this proposal is based. These are so indicated by asterisks in the list of references.

This chapter presents research findings from that literature to establish a basis for a meaningful and rational curriculum analysis by: reviewing the educational experience and characteristic salient features; examining various functions of an educational system; discussing the student variable; describing goal determination in educating for the future; and summarizing curriculum guidelines.

THE EDUCATIONAL EXPERIENCE

It has been indirectly observed that a majority of the public equates going to school with getting an education. Yet, some students on campus seem to express the conflicting opinion that going to school to learn something is a mistake. The context of these expressions is not important here, but this apparent contradiction leads one to speculate about the concept of an educational experience, its scope, major functions, and significant factors.

The formal educational experience is, in reality, the grand total of all actions, interactions, and relationships influencing an individual's learning for the duration of one's active participation in the educational setting (Rosenstein). It may be described as being composed of two main elements: the paracurriculum, which is defined as the body of out-of-class experiences which help to strengthen the intellectual ability, general background, and coping powers of the student (Shane:53); and the academic curriculum, which is the framework for formal studies (and may be usually the lesser component of the educational process)(Figure III-1).

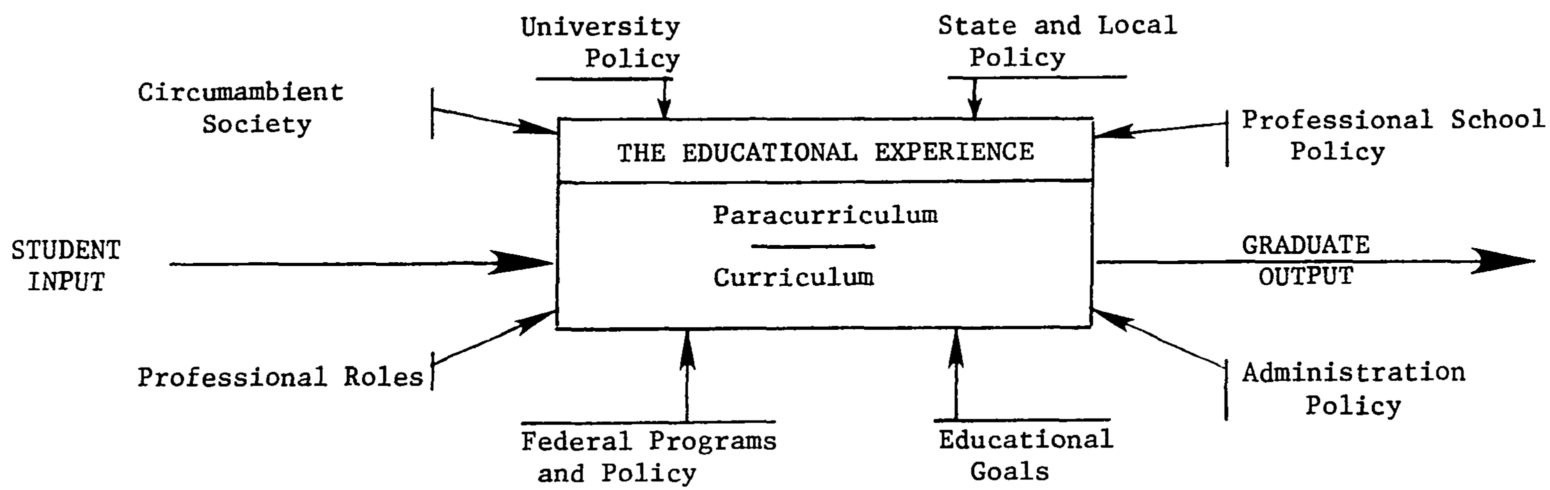


Figure III-1, THE EDUCATIONAL EXPERIENCE

Paracurriculum

A descriptive listing of some sources of student interrelationships which are elements of a paracurriculum and significantly impinge on the educational experience includes interfaces with the following:

1. Departmental and interdepartmental faculty.
2. Department, school, and university administrations.
3. Student, professional, and honorary organizations.
4. Other extra-curricular activities including the performing arts, athletics, and special activities such as guest lecturers, film reviews, and symposia.
5. The local circumambient society (commercial, political, government, and business.
6. Activities centered around religious organizations.
7. Peers, friends, and family.

Interactions with these elements serve many educational factors and are products of the educational experience apart from the academic curriculum. They occupy an extremely important place in the total education of the participant and should be seriously considered by curriculum planners for integration with the academic curriculum and included in implementation strategies. Some educational factors assembled by Dalkey (QOL:II-219) which could be served by the paracurriculum include:

1. Greater creativity and expanded imagination.
2. Broader outlook, new perspectives, new experiences, knowledge, curiosity, and desire to learn more.
3. Social awareness, relationship of individual with environments, cultural awareness, and awareness of social problems.
4. Social skills and ability to get along with others.

5. Responsibility and concern for society.

6. Tolerance, decrease in prejudices, open-mindedness, and understanding of others.

7. Development of life goals, purpose in life, and competitiveness.

In view of these factors, the importance of the paracurriculum on the effects of education cannot be overemphasized.

Curriculum

The foremost implication is that in the decision-planning of an academic curriculum, an effort should be made to take full advantage of these factors by:

1. Designing into the academic curriculum as many as possible of the positive and desirable effects of the paracurriculum.

2. Attempting to set the stage for strong social development directed toward professional responsibility, accountability for actions, and interdisciplinology.

3. Designing out of the total educational experience de-motivating negative factors such as impractical education, disillusionment with educational usefullness, irrelevance, prescribed education, and trivia.

Detail of all course contents should be continuously measured against the effects on the total educational experience.

Curriculum Development

Characteristically, the impetus for curriculum development, or reform of on-going programs, is the manifestation of needs generated from a combination of situational stimuli which demand an appropriate training response. The types of processes which are used in this regard, either independently or in combination, can be described as the reactive type, the ad hoc technique, and the rational analysis approach.

The reactive type of academic reform is usually distinguished by a patchwork system of incremental updating of a program to satisfy short-term imbalances. Over a period of time, patchwork overlays patchwork and the ultimate program is characterized by a quagmire of uncoordinated educational activity accompanied by an often unidentifiable vagueness of educational objectives. Correlation between the needs of society and the capabilities of the graduate is strictly in the time frame of the present and the past.

Another type of contemporary academic reform is through the use of the ad hoc committee, so gathered for that specific purpose. Recommendations for change usually appear in the form of a report. This one-shot exercise may occur at planned regular intervals or at unplanned irregular intervals, depending on the degree of quiescence of the reform stimuli. One thing appears certain--the impact of such efforts may be negligible because the report usually ends up on a library shelf. At best, fragmentation and extensive amendment of the report renders any potential contribution questionable.

The third type of curriculum reform is the use of a rational analysis. In this case, the curriculum is designed to respond to anticipated changing needs of society, the profession, and the student by matching these needs with the future capabilities of the graduate.

Three functional methods for these processes may be described as follows:

1. Empirical. This describes the situation where an individual or group of individuals sit down and collectively "brainstorm" their opinion of an

appropriate curriculum. By this method, attention is often given to correct obsolescence and relevance by correcting course content. This usually proves to be a futile effort because such stop-gap methods cannot withstand the tests of time. As P.H. McGauhey says in describing such treatment of courses, "...revise, rewrite, delete, deplete, de-gas, de-water, and debunk" (McGauhey:49).

2. Hybrid. This is when the curriculum writers stroll through the supermarket of nationally in-place programs (e.g., Register) and fill their curricular pushcarts with what they consider to be the best of available alternatives. This exercise in self-hypnosis does not necessarily constructively contribute to any curriculum planning goals or objectives.

3. Functional Analysis. In the evolution of curriculum design-planning techniques, some logical reasoning system seems to be taking shape. Examples are many (Austin, Christman, and many others). A recent attempt to set up a rigorous and objective system of educational design was studied and developed at the University of California at Los Angeles by Dr. A.B. Rosenstein. (The technique of the Professional Method developed by that study served as a valuable guide to the conduct of this study.) Another excellent and timely study of engineering education is a recent report prepared by the Center for

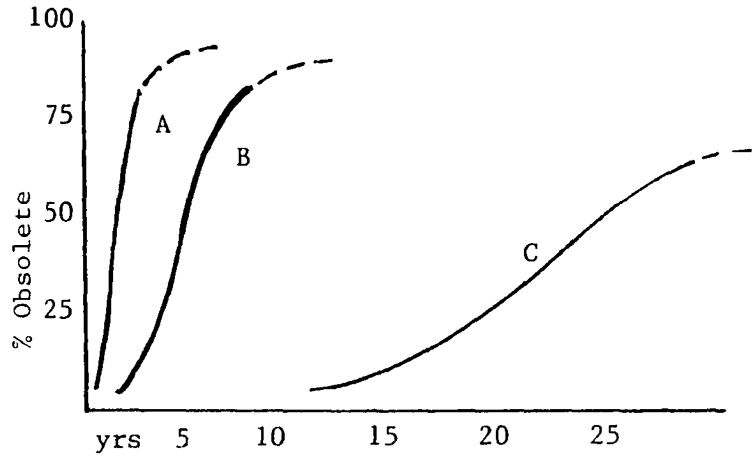
Policy Alternatives for the School of Engineering at M.I.T., J.H. Hollomon, Chairman. (Hollomon)

Potential Obsolescence

The impact of the exponential rate of expanding knowledge and technology has precipitated interrelated questions of academic relevancy, obsolescence, and timeliness. Since the half-life of an academic course is about five years (Rosenstein), should the educational objective of a program be performance-oriented by stressing how-to-do-it methods on the crisis of the moment, or should an alternative program of conceptual orientation be implemented where the graduate could attack any crises that nay occur over time thereby making a significant contribution to man's social and cultural advancement? Perhaps this is not an "either-or" proposition but should be answered in terms of both, since employability and financial necessities at the exit gate of graduation are important factors.

In an attempt to arrive at a reasonable position, it would appear that potential obsolescence would be one major factor in curriculum structure and course development. Because of the rate of onset of new problems and changing crises, students trained in solving the problems of the moment would probably be obsolete in that function in an extremely short period of time. Even if no other factors were considered, a cursory cost-effective analysis would negate such a nearsighted philosophy. Implicit in obsolescence is the need for almost immediate retraining or re-tooling. In-depth specialty areas might be susceptible to this characteristic (Figure III-2).

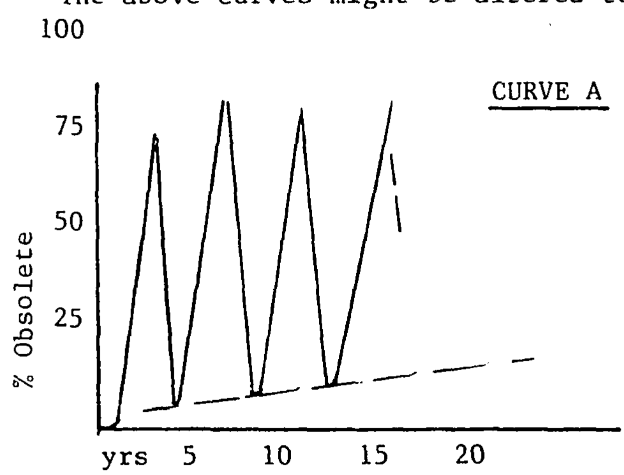
A basic technical language is fairly long lasting and can be



A=Problem oriented
B=Present curricula, half life of five years
C=Future oriented

This graph suggests the relationship of time and total curriculum (and therefore graduate) obsolescence. As the rate of change of knowledge and technology increases, the slope of each curve would become steeper. (Individual courses and course content could also be plotted in a like manner. A negative slope is quite possible and perhaps describes many courses and course contents in use today but hang on due to tradition and perhaps tenure.) The following graphs highlight the importance, the rate of and need for continuing education.

The above curves might be altered to look like the following:



This would appear to be undesireable and not very cost effective. The magnitude of retraining is quite high and consumes an exorbitant amount of time relative to production time.

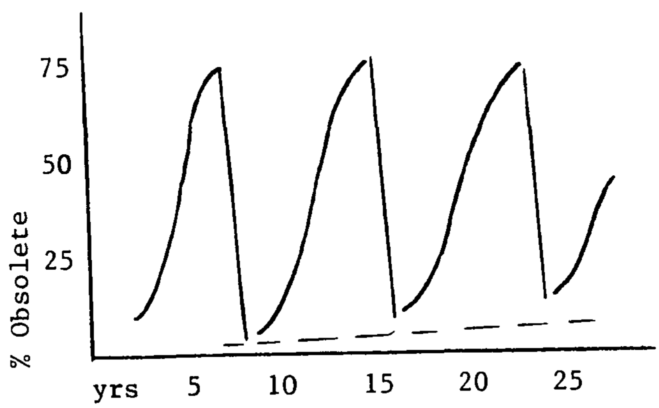
X - down curve a function of the exponential growh of information, technology development and implementation

Y - a carry-over function prevents down curve from ever reaching zero

Figure III-2, POTENTIAL OBSOLESCENCE

Curve B

Retraining



It is recognized that continuation training exists in many forms and would not necessarily be lumped as shown here. This graph only represents the general trend and effect of a continuous retraining effort.

Curve C

The wisdom and advantage of a future-oriented program is obvious in terms of magnitude, duration and frequency of up-dating.

Retraining

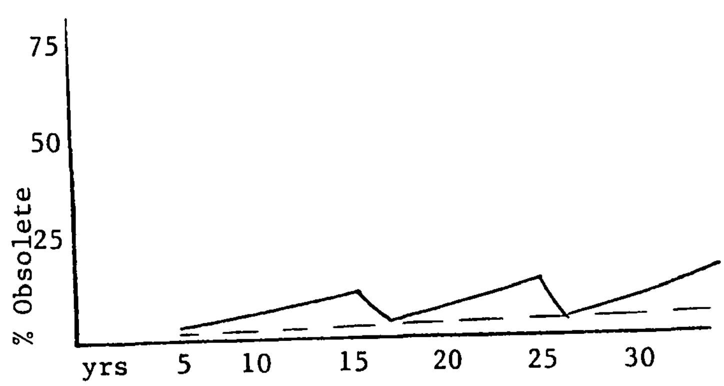


Figure III-2 (Continued)

updated quickly, but advances in the technical state-of-the-art quickly overshadow specialized know-how. Therefore, studies leading to breadth of knowledge should be presented which would provide the student with a familiarity of the principles, information, and tools by which he may confront many problems occuring over time.

FUNCTIONS OF EDUCATION

The task of education is two-fold: first and foremost is the transmission of ideas of value; second is the transmission of know-how or disciplinary ideas (Schumacher:75). Together, these functions impact on the cognitive style of the student, the cognitive style being described as an individual, pervasive, and deeply rooted way of thinking and learning which is unique to each person (Hollomon:20). The concept of the total educational experience is to affect an individual's cognitive style, according to educational goals, by changing the knowledge, skills, values, and attitudes of the student. The curriculum and paracurriculum are the mechanisms which interact and combine to accomplish these tasks.

Values

The transmission of ideas of values, however, is not so easily identifiable or definable, yet is perhaps the most important and basic component of the educational experience. In the absence of a methodology for dealing with values, it is a difficult realm to discuss except in broad terms. The important point is that the curriculum designer should try to understand what values the training program transmits and how they are being transmitted. These values give direction and meaning to an individual's future professional activities. The student also has a responsibility to understand the values he is being exposed to and how they may be affecting cognitive style. The scientific approach of continuous challenge and questioning is the primary technique for exploring alternative values.

Know-How

The technical disciplinary language is the essential medium for imparting such items as technical competence, disciplinary terms, analytical methods, assessment competence, and judgemental competance. Each word of this technological language expresses specific concepts and ideas. The way a person visualizes and interprets the world depends on the kinds of ideas that that person possesses. These technical ideas constitute a powerful set of tools which a person brings to professional activities in the pursuit of a career (Schumacher).

Chapter IV further explores the subject of values and professional responsibility and suggests techniques for including value clarification in the curriculum.

CONSTRAINTS

Constraints on an educational system are active at three levels of concern: institutional, socio-economic, and individual. At any particular institution, each of these entities is peculiar to its own local set of circumstances and describes the boundaries within which programs function. These boundaries establish the limits of acceptable purpose, thought, and action, set the tone of the educational experience, and interact to form a complex structure for the educational setting.

Institutional

Administration - The administration of an institution is charged with the support, supply, and management of the separate parts of the university community. The administration is that whole assemblage of staff, professionals, employees, vice-presidents, and others both from the faculty and outside the faculty. The administration has, as its perspective, two identifiable functions: to serve the interests of the university from the point of view of executing existing policy, and to invoke change. The central missions that the administration serves may be described as: internal self appraisal function, the role that the university plays in society (outreach), the university community, administration and finance, operations, university projects, and university relations. State government, and the State Board of Regents, through the university president, establish policy and administrative boundaries which affect all levels of activities including student and faculty constituents (Christenson).

Faculty - It has been a well established tradition, readily accepted by the regents, that the faculties of the colleges act on their own regarding academic standards, standards of admission, standards of instruction, and graduating students. The faculty preserves and extends tradition and does it from deep in the past into the future. The faculty is a conserving force in the university; they preserve, extend, and transmit it. They also transmit a cultural attitude and are ideologically oriented in that they have a point of view to express which is the western tradition; the dignity of the individual and all that it connotes. These traditions have their roots and philosophical assumptions going back to the Judeo-Hellenic-Roman-Christian traditions. Even though a faculty may become vocally liberal, the identity of the faculty as a whole is considered to be a conservative body (Christenson).

Another characteristic of a faculty is that there may be greater loyalties world-wide and nationally within a discipline than there are institutionally for the purpose of knowledge or the mission of the university. The enclave syndrome, where faculty may go outside the university to protect themselves inside the university, has been supported in some instance by direct grants from federal agencies for various disciplines (Christenson).

As the direct link between the university system and the student, faculty abilities and capabilities tend to be a constraint on the educational delivery system. Faculty abilities refer to powers of perception, analysis, intuition, communication, adaptability, and creativity. These abilities are usually pre-determined; that is, they are brought to a classroom as a cognitive style. They are skills that can be honed but not necessarily taught--more of a product of childhood environments than success in controlled learning situations.

Possibly just as important as ability are the experiences an instructor brings to his position. Experience promotes depth, range, and a creative response to problems that faculty must contend with. Faculty motivation, enthusiasm, and interest in the student can also be a serious constraint to the success of the educational program. Lack of teaching interests are reflected in research and public service activities which, if not properly directed, may compromise instruction (also, see Faculty Roles).

Evaluation - Most educational institutions strive to bring the quality of academic programs to a level sufficient to achieve accreditation by an outside evaluating committee. Opinions vary widely among educators as to the feasiblity or desirability of accrediting graduate programs. Engineering schools may invite the Engineers Council for Professional Development (ECPD) to evaluate faculty, curricula, caliber of students, and intangibles such as the quality of the learning environment. An accreditation lasts for a period of two, four or six years, with reappraisal stipulated at the end of the period. If a program were to receive such an evaluation, the accreditation criteria might have an effect on the design and conduct of the system.

Physical plant - Buildings from which to administer, conduct classes and laboratories, store supplies, etc., are all prerequisites to establishing any program. The quantity and quality of the physical plant needed for the various functions and objectives of the program, combine to define constraints as to number of students, flow rates, offerings, and scope of the total program.

Time structure - Each institution is administratively structured into semesters, quarters, etc. As a constraint, the program must be designed to fit that structure. Variations to accommodate unique presentation or study methods should be seriously scrutinized and measured against student needs and capabilities on an individual basis.

Socio-Economic

Socio-economic constraints are derived from the characteristics of the national socio-economic system as well as the local situation which the university serves. These constraints generally lie outside of an institution's ability to control them directly although institutions and students both react quickly to economic incentives. Their impact can be mitigated, perhaps, but not changed or eliminated. Ability to deal with these factors can greatly affect the quality of education.

Local cultural patterns and mores of the circumambient community establish the environmental tone in which the university functions and tends to mold the character of the university to approximate local attitudes. Perhaps these constraints are mitigated to a degree by bigness, either of the institution or the surrounding community, or both. Bigness tends to dilute or break down the homogeneous moral and cultural patterns.

Socio-economic factors which may impact on the training program must be identified and considered at the local level. These especially include support funding sources for training and research. Increasing costs of education may tempt students to forego training or complete segments rapidly. Federal support for graduate programs are decreasing rapidly (e.g., recent phase out of EPA training grants in Environmental Engineering) requiring the institution to search for new sources and arrangements perhaps from business and private industry sources.

Individual - See next section, The Student Variable.

THE STUDENT VARIABLE

A significant educational design parameter which must occupy a prominent position of concern to the curriculum planner, is an understanding of the nature of the persons flowing through the training program. Historically, student characteristics and needs apparently have received only passive attention. (Indications are that this lack of concern may contribute to a sense of dissatisfaction with higher education which some students manifest.) The primary student need is personal growth and fulfillment in terms of intelligence, creativity, and development of potentialities. The curriculum should significantly contribute to this growth of the student.

If a program is to be successful, there is a definite requirement to be familiar with salient student characteristics, needs, and motivations collectively and individually. Certainly, not all engineering students are alike, and no implication is made to label, categorize, or classify, but a character profile could be used very effectively to aid in the optimization and efficient design of the educational experience.

Mutual Characteristics

Studies and observations have already been conducted which provide an insight into the nature of engineering students and may be summarized as follows (Hollomon:17):

1. Possesses modest aspirations but is highly competitive with a strong desire to improve the socio-economic status of his predominately middle or lower class background.
2. Has strong career orientation as a job.
3. Values task completion as opposed to task initiation.
4. Is domineering and authoritarian.
5. Has lower than average interest in and avoids exposure to fine arts, people, aesthetic values, history, foreign languages, and philosophy.

Even though this is not an exhaustive or complete list, it does serve to expose some subject areas of needed attention and emphasis, notably the human and social issues and value systems.

Motivation

At the graduate level of education, students are usually more personally motivated in their studies than the average undergraduate. This is not to say that they necessarily know where they are and where they are going, or that their career choice will not change, but that a student's mere presence in graduate school indicates a more highly developed goal-oriented motivation. Motivation may affect the breadth and depth of learning and, therefore, continuous positive motivating influences should pervade the program. This can be designed into the system in a variety of ways, notabley perhaps, by emphasizing the correlation of his learning with the industrial and community setting through local business connections or governmental agencies, studies which impart a future focused self-image, and through organized contacts with the professional practitioner.

Most students also feel a certain self-importance and naturally require appropriate recognition of independence and individuality. An active and dedicated faculty interest in each student can go a long way toward fulfilling this need. As a positive motivating factor, the system should provide for recognition and appropriate rewards (e.g., certificates, diplomas, M.S. Degree) while de-emphasizing seams or graduation gates. If an educational program alludes to excellence, success, and effectiveness, it should be dynamic and possess a certain charisma, not the least of which is supplied by a student-oriented, dynamic, and interested faculty.

Eligibility

The formal educational background which has prepared a student for participation in a graduate program should not necessarily be rigidly or indiscriminately specified. Because of the interdisciplinary nature of the problems of environmental systems, and also because of several possible functional emphases (system design and management), students can come from several disciplines: civil engineering, industrial engineering, chemical engineering, operations research, and science. A desired background schedule of the curricula would be:

CE - Chemistry, Biology, Statistics

IE - Chemistry, Biology, Water and Sewage

ChE - Water and Sewage, Biology, Statistics

OR - Chemistry, Biology, Water and Sewage

Science - Chemistry, Physics, Limnology

The proposed program is not built on a solid undergraduate foundational program--input students are diverse. Therefore, any of the interested disciplines that had senior or graduate standing would be eligible.

Open Curriculum

This concept recognizes the fact that there is a place for anyone to participate in studies of environmental concerns, and any person, at any reasonable level, in any position or station in life, should be allowed the opportunity to participate in any element or portion of a curriculum. A prospective student should be allowed to enter or exit the program at any point, for any reason, without penalty to the student or the institution. Among the several purposes served by an open enrollment are:

1. Moves toward a seamless continuum of education.

2. Encourages enrollment from all walks of life.

3. Provides the opportunity for the institution to take a more active role in, and servcie to, continuing education.

4. Allows for a free flow of students from other areas of interest thereby helping to provide a platform for the interaction of different disciplines.

An open curruculum implies the reduction or deletion of course prerequisites. This controversial question can only be resolved at the local level but should be approached in the light of the broader objectives of the program relative to the purposes and advantages listed above. In any presentation, there will be student academic shortcomings of all types, and faculty counseling should be carefully utilized to advise a prospective student of the nature and specificity of certain basic subject matter deficiencies. A personalized approach concentrates on the learner's optimum development rather than focusing on attempts to bring the student up to some undefined group norm. Personalization of instruction will include recommendations for independent remedial studies in the best interests of the student. A variety of techniques may be employed in unique combinations to accomplish this without detracting from the program (see Appendix C).

Composition

The majority of entry students may be a fairly homogenous mixture of persons trained in engineering fields (CE, IE, ME, ChE, etc.) or the sciences (Botany, Chemistry, Biology, Physics, Public Health, etc.). A significant portion (perhaps even more so in the future considering the increasing numbers of women, and minorities) will be a growing heterogeneous mixture of various backgrounds including economics, law, literature, education, arts and sciences, etc. A smaller proportion will be those without particular educational or professional goals but who will participate in the role of continuing education. This changing composition may change the mix of attitudes, needs, and backgrounds slightly and must be anticipated and monitored by the local unit.

Student composition (and motivation) may also be radically affected by such circumstances as economic recession/inflation resulting in unemployment and monetary disparities, government policy and regulations which vary the flow of supportive funds for education, training, and research, and energy, pollution, or other resource crises.

As pointed out in the Hollomon report, immigrants comprise 6% of the current undergraduate enrollment in engineering, and 27% and 33% of all M.S. and Ph.D. candidates, respectively. Only 44% of foreign nationals will eventually find employment in their home countries. There is a higher percentage of the total number of foreign students in civil, chemical, and mechanical engineering than their American counterparts, and employees with graduate degrees reflect this trend of increasing foreign participation in the U.S. job market.

Women in the U.S. have traditionally comprised only a small part of the engineering workforce. In 1970, only 1.6% of all engineers were women. They were most often found in industrial, electrical, and aeronautical engineering and least of all in mechanical engineering. Women tend to hold jobs more frequently in service sectors, public administration, transportation, utilities, and communications.

Monorities comprise an even smaller group of engineers than do women. Only 1.2% of all engineers are black, although in the U.S. they comprise 11% of the total population.

These small numbers of women and minorities in engineering can be expected to increase in the future. The experience in Russia training women as engineers on an equal basis with men has proven their ability to perform as well as men in engineering tasks. As more women and minorities seek to develop recent opportunities for employment in professional positions, white male domination of the profession will become less pronounced. The already rapid absorption of foreign nationals into engineering ranks points toward a broader makeup of engineers as a group.

Social Background

The social background of each student greatly influences his attitudes and receptivity to formal education. Many universities seemingly have been mainly concerned with the education of the white middle class to fill needs in an economic and political structure dominated by the white middle class. Persons without the attitudes, aptitudes, and social values of this dominant viewpoint will be quickly frustrated in the formal educational setting. Those who can adapt or conform to the mold will find progress facilitated.

With the influx of more women and minorities into the system, university administration and faculty need to adjust their traditional activities to satisfy needs peculiar to these students. Curriculum design must also be sensitive to the constraints imposed by the strengths and limitations of language, analytical ability, and expression differences.

Different students learn differently and at different rates. No single method of instruction matches the learning abilities and capabilities of all students. Flexibility and attention to student needs by the faculty is imperative for providing an effective program which meets objectives.

FACULTY ROLES

The primary commitment of a university is to the growth and development of each individual in the university community operating through programs of instruction, service, and research. Faculty responsibilities parallel these functions and serve as one instrument in carrying out the various programs.

Instruction is the historic and basic role of the university. This role may be conceived as a process in which instructor and learner experience problems and communicate about the solutions to these problems. The role of research may be defined as a continuing effort to organize and add to the store of existing useful and potentially useful knowledge and to provide for fresh and noble expression of man's creativity. Services to the circumambient society may be provided in areas in which staff and facilities are available. Because of the direct contact between students and faculty, it is essential to explore the ways faculties carry on these functions in the university community and discuss desirable characteristics and strategies for effective utilization.

A faculty must be provided whose talents form an interdisciplinary team of specialists who are dedicated to substantive involvement in both intra- and extra-mural studies, research, instruction, and service. Each specialty faculty group must be in sufficient depth to permit periodic absence of individuals from the campus to permit activities which will reinforce the teaching role. (see Figure III-3.)

Many vitae in catalogues, registers, and program flyers describe faculty activities in terms of percent allocation of total time (e.g., 70% research, 30% teaching), followed by a listing of publications and research interests. These items may or may not illuminate strong points of the school offerings. The accuracy of these fractional representations may be very questionable according to many individual observations and are usually based on the faculty member's estimate. They also illustrate points of serious conflicts of interests between faculty and students. Most students may be confronted by an extreme disinterest in them even though classes are generally met and notices of office hours are posted and counselors are assigned (Mood). In many instances, the student looks on higher education to train the next generation, but faculty incentive orbits "system" incentives--those items which determine one's academic status such as offers from prestigious universities, rate of promotion up the academic ranks, salary, bargaining power for research grants, and others.

The faculty's pursuit of its special interests generates significant distortions in higher education. Of course, not all professors are so inclined and are quite concerned about the welfare and development of the student. In general, however, ways must be found which will tend to align student expectations and faculty resources such as formal evaluation of the faculty (published in vitae?), grasp of subject matter, devotion to good teaching, teaching preparedness, availability and receptivity for counseling, and attentiveness to special needs of students. Perhaps the students should have a formal

Program \ Resource	Chemistry	Biology	CE	IE	Law	Planning	Philosophy	ME	Social Sciences	Math	
Civil Measurements	X	X	X							X	
Urban Systems			X		X	X		X	X		
Humanities					X		X		X		
Forecasting			X	X					X	X	
Assessment	X	X	X							X	

Each 'X' represents portion of FTE for participation in a particular program.
Each course in a curriculum needs to have all resources carefully scheduled.

Figure III-3, COMPONENT STAFFING

role in the processes of employing and promoting faculty members. By the same token, faculty should be willing to take appropriate action and revise practices. Faculty evaluation of administration and institution should be encouraged. These may be some giant steps in the middle of extreme controversy and can only be resolved at the local unit. Nevertheless, if an educational program is to be successful, it must strive to have instructors who are genuinely interested in their students.

Good teaching involves a second level of activity, counseling, which consists of assisting students in remedial and independent studies, encouraging independence and creativity, and advising study directions in the best interests of the student.

Faculty time is also necessary for curricula development, not as a bootleg activity but as a scheduled responsibility. As stated elsewhere in this study, educational goals must be continuously evaluated and redefined according to changing needs. To provide meaningful input to curriculum development, the instructor must search the horizon for changes in the profession, from society, and the students. Ad hoc, one-shot, five-year incremental curriculum evaluations should be discouraged. The instructor should be future-focused and able to adapt to changing conditions easily, confidently, and willingly. The faculty needs to schedule and allocate various activities realistically and the administration should support the time requirements necessary to carry out those functions. Conflicts should be resolved whenever they are uncovered.

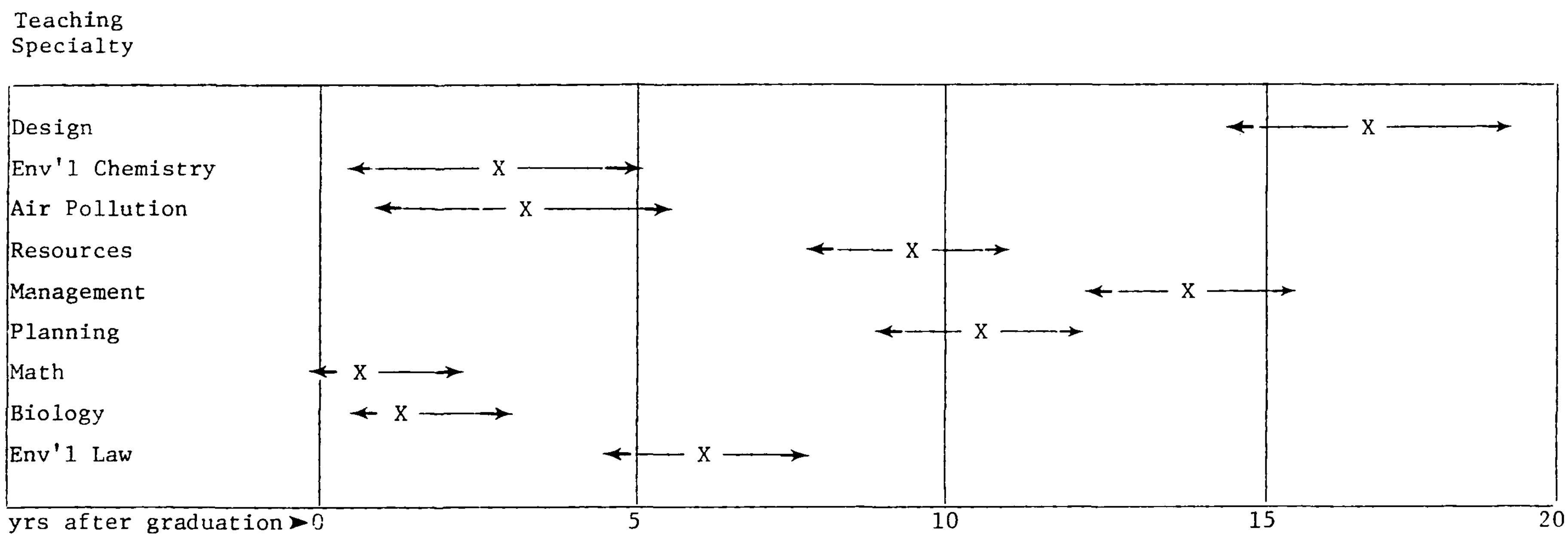
The correlation between success in graduate school and teaching ability is in considerable doubt (Mood). Therefore, the feasibility or desirability for a particular degree requirement for faculty positions should be dropped, unless, of course, the position is primarily for another function such as research. Perhaps the distance between the campus and the rest of the world could be reduced by not permitting anyone to be recruited to the faculty who has not had at least some years experience outside of educational institutions. Many hold the opinion that to be an effective teacher of engineering, one must be first and foremost a highly competent up-to-date engineer. Through an enrichment program entitled "Faculty Residencies in Engineering Practice" sponsored by ASEE, selected young faculty members receive the benefits of 12-15 months of practical engineering experience. Nearly 100 consulting firms, public utilities, government agencies, and industrial companies have provided faculty opportunities for full-time involvement in engineering practice.

Perhaps certain cognitive areas could be taught by recent graduates, but other areas such as design, management, and planning may require different recruitment policies involving practical experience in the field to be an effective teacher (Figure III-4). This requires careful evaluation, planning, and policy-making by the local educational unit.

Service to the community may also reduce the gap and help promote quality education by bringing alumni and local businesses directly into the educational enterprise.

New dimensions of faculty awareness entering the educational scene stem from the increasing need to consider the rational use of technology and professional responsibility. Consideration of social,

CONCEPTUALIZATION



Key:

X entry point into faculty

⟷ possible range depending on individual and experience

Figure III-4, FACULTY ENTRY POINTS

political, and ecological conditions are required in addition to considerations of morals, values, and ethics. Values transmitted by the educational system through the faculty should be explored and recognized by the institution. The instructor must also be prepared to allow for the differing viewpoints of the different professions and disciplines and be willing to work with them in guiding teaching and public service.

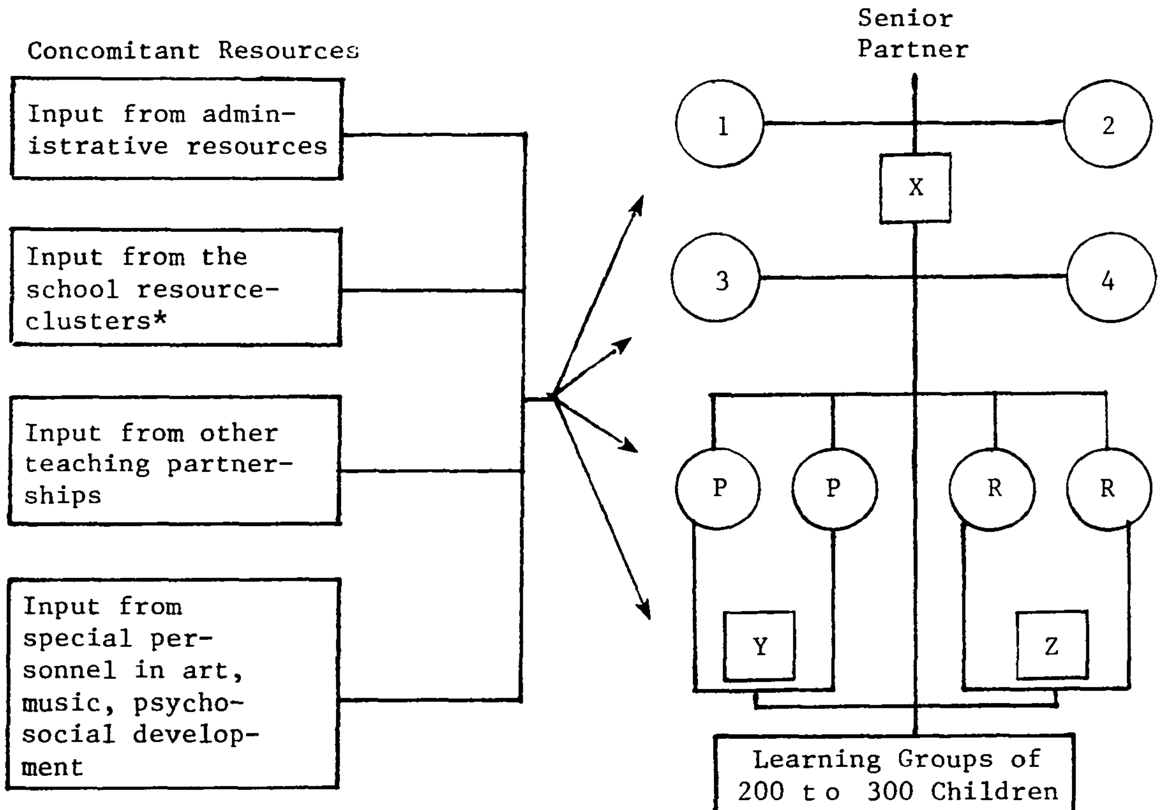
If a faculty member is to be involved in all programs of the university, realistic time allocation is essential and should start with the primary function of the individual instructor. If a faculty member is spread too thin or favors one function over another, effectiveness of all functions suffer and the purpose of the university is compromised. McGauhey notes that the changes in the world are so rapid "...that it becomes absolutely necessary that a professor be doing something in research." (McGauhey:193). This demand must be balanced with the other demands of teaching and service. As educational costs increase, however, teachers may be required to handle more students and thus do less research, writing, or practical work. A micro-activity analysis should be used by the faculty to enable full accomplishment of tasks.

Interdisciplinary and multi-professional programs may also require differentiated teaching partnerships such as the one suggested by Shane (Shane:9) which involves a careful orchestration of available resources by the senior teaching partner (Figure III-5).

EDUCATING FOR THE FUTURE

In the design of training programs, the basic problem is to provide the graduates with the attitudes (values) and the tools (know-

MODEL OF THE TEACHING PARTNERSHIP AND ITS ASSOCIATED SUPPORT SYSTEMS



* Resource-cluster components include: (1) a guidance center, (2) computer facilities, (3) materials development staff, (4) instructional systems-technology cadre, (5) biochemeducationists, (6) human relations center, (7) S-R center, (8) evaluation-assessment and performance Analysis center.

Characteristics

1. Flexible teaching partnerships
2. A seamless curriculum continuum
3. Variable professional responsibilities
4. Shared contacts with several learning groups
5. Personalized instruction
6. 12-month "overstaffing"
7. Principal "teams"
8. Individually variable school year
9. Increased use of paraprofessional (P) and residents (R)
10. Academic balance among partners
11. "Open School" concept
12. "Fail-Safe" guidance

Source: Shane:6

Figure III-5, TEACHING PARTNERSHIP

how) to make them productive in the future. The future is, or course, uncertain (except that it will not replicate the past). Significant changes in recent years (such as the increase in demand for services and information as opposed to the producation of goods, long-term increases in leisure time, and engineering employment shifts) can all serve to illuminate capabilities which the graduate should possess.

Traditional civil engineering programs have followed concerns with the categories and functions of the built environment (i.e., categories such as building, roads, water supply, solid wastes, waste water treatment, the environment and its impacts) and functions such as analysis, design, construction, planning and management. Teaching by categories strives to produce designers, planners, and investigators with specialties in analysis and design in water structures.

In addition to the shift of interest to the service sector, a new element to the environmental system has been added; that is, the size of the urban problem and its multiple interactions. The built physical complexes have all the categories and functional components as well as large socio-economic-political components. The complex interactions of these components are necessarily at least as equal in input as some of the physical components.

A responsive curriculum, then, should be structured (or boxed) so that study can be arranged by substance (category) or by function, with capability to pursue one category in depth or the entire interacting system.

Goals

A most critical element of educational design is a continuously developing and responsive set of goals, or "pipe dreams" which express the reasonable assessment of the future problems. These are the matters to which curricula and courses must address themselves.

Goals may be investigated from the viewpoint of the educator forecast, the consumer forecast, and also from a modeling of society. Educator surveys must be used with extreme caution due to a tendency for the perpetuation of self image and the status quo, as well as biases of class and age. Consumer surveys may also suffer from biases that are associated with an overidentification by the desire of those in practice to expand and secure their activities. Urban system modeling, however, may be used effectively to help relate determinants to both physical and non-physical needs of society (Reid, Mood:37, Forrester). In this way, new and modified courses may be suggested with particular reference to urban and regional environmental systems. It is important to institutionalize this process whereby goals can be continuously appraised so that the curricula and courses can be structured or modified to meet changing requirements but maintain a stable training program.

Other predictive sources available to the curriculum planner are:

1. Organizations and institutions which study and predict the future. Examples are many, including sources associated with the World Future Society, Institute for Policy Studies, International Society for Technological Assessment, and many others. The line-up contains corporations, government agencies, and educational institutes.
2. Manpower projects prepared by governmental and regulatory

agencies and professional societies, which indicate future needs based on futures studies.

3. Studies on the future of education and educational institutes which have been completed or are in progress.
4. Policy formulation study groups in governmental agencies and institutional programs.
5. Reports on research projects and research funding trends.
6. Educational trends from programs in place and developing at other institutions.
7. Information feedback from professional societies.
8. Information feedback from public and private entities concerned with environmental conditions.
9. Student needs and opinions.

Information from these sources help to describe what circumambient society may look like in terms of indicators such as population and population trends, migration trends, advances in the sciences, economic conditions, key engineering needs, continuing educational needs, etc. Other items which need to be determined are specific environmental problems and identification of problem categories requiring attention in the near future (EPA-600/5-74-005). This information contributes to the possibility of the establishment of priorities (long- and short-term) which serve as guidance for the allocation of available resources.

A Working Scenario

Population increases and the migration trend to suburban areas thus creating the megalopolis--provide new opportunities and advantages of living in very large urban areas but also present new problems of providing not only life sustaining necessities but psychological and sociological amenities as well. Planning for the built environment is a necessary consequence of migration trends and will require concentrated accommodations in an area not accustomed to these requirements. Medical services, education, housing, transportation, water, sewage treatment, communications, and many other needs of the populace require organization, careful planning, and concerned management of current and future needs. Urban areas in the next few years will likely see the abandonment of individualized transportation and the advent of electronic communicators by which one can shop, receive medical service, and take care of other basic needs without leaving the house. Instant and widespread availability of data through individual terminals will provide a better base for accurate and timely decision-making. Housing accomodations may become more concentrated in facilities such as condominiums, row houses, and town houses. Interspersed with the large urban area will be Urban Wilderness Areas for the preservation of natural flora and fauna and for recreational needs. Planning must include the attainment and maintenance of a high quality of life.

Local and state governments may tend to become more regionalized to a greater degree than is observable today. The contemporary trends of centralized area-wide planning agencies provide models for the evolution of governments over areas with interrelated problems and geographic proximity. Arbitrary boundaries will remain for the sake of record keeping but otherwise will lose their status as their reason for being becomes less evident. The federal government may become more centralized in certain areas and more diffuse in others according to the dictates of efficiency and the need for on-the-spot response.

The development of large urban systems has brought about a profound change in the structure of the economy over the last few decades. Trends begun after WW II toward a more service-oriented economy will continue into the future and will dominate overall output even more than now. In 1950, the goods and service sectors each employed about 26 million workers. By 1970, production of goods employed 29 million and services 46 million (Hollomon:10). This trend is indicative of the increasing numbers of durable and nondurable goods being produced in plants utilizing a high degree of automation and sophisticated machinery. Production of hardware will continue to expand in the future in response to the needs of a growing population, but will also continue to lose significance as a generator of GNP as the service sector increases its share of overall economic activity.

Productivity of the average worker in manufacturing has increased even though the percentage of workers in this sector has dramatically declined. The service sector has grown correspondingly to provide services demanded as a result of the widespread deployment of machines and the increased leisure time available to people with a shrinking work week accompanied by expanding bank accounts.

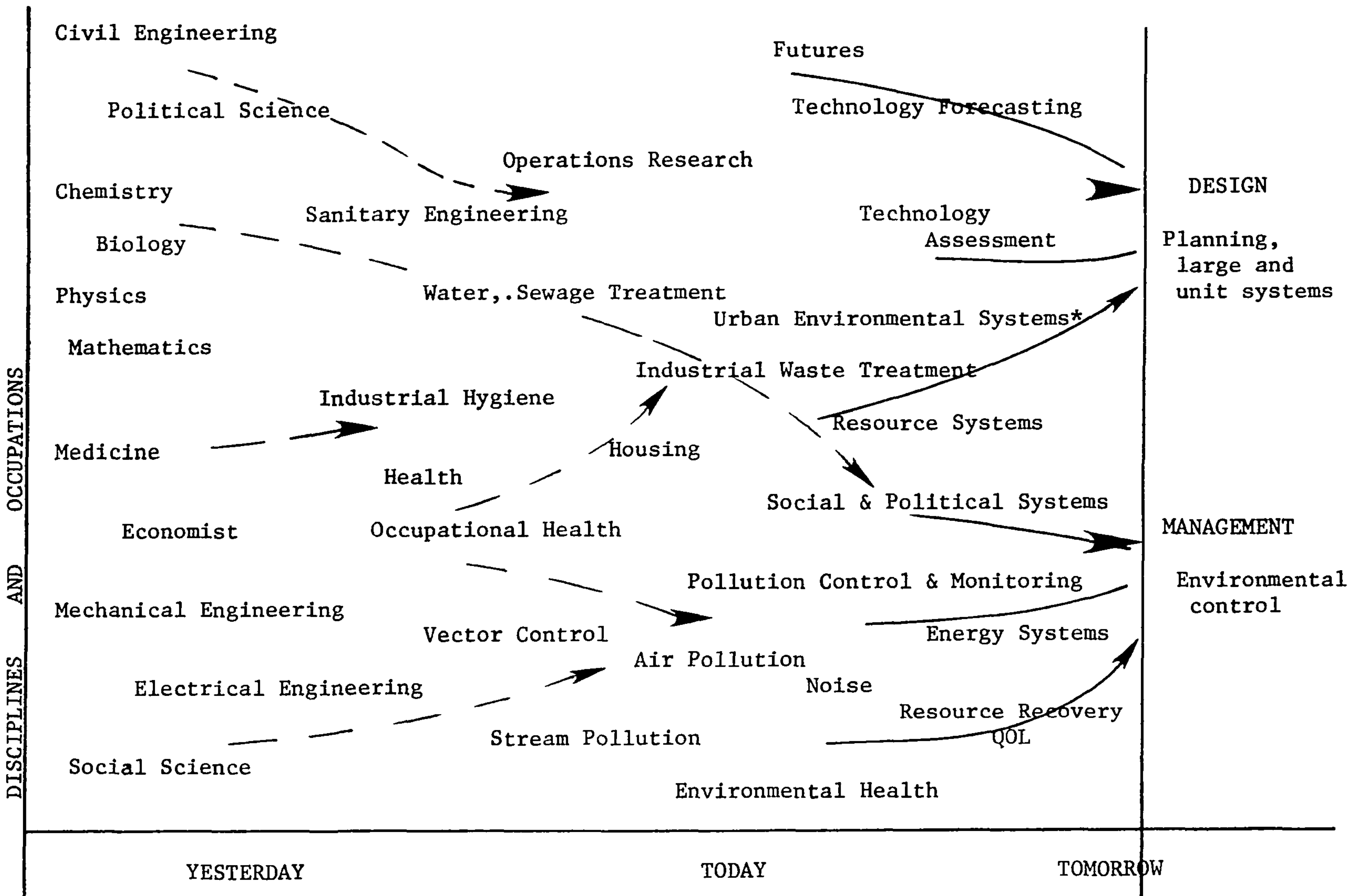
The dilemma of inflation/recession will undoubtedly affect the price society is willing to pay to control technology and maintain environmental concerns. The dominance of energy resource extraction may prevail over concerns for the biosphere in spite of vigorous protests. Again, energy and the environment is not an either-or proposition, but a situation where both must be accommodated through a series of informed trade-offs recommended by professional people involved in policy and decision-making processes. Such an exploration illuminates the future faced by the graduate.

Curriculum Directions

The universal recognition that urban problems are no longer isolated has been extensively documented. This means that responsive education can no longer remain isolated in disciplines if it is to serve the community effectively. Understanding, protecting, and maintaining our environment requires a totality of approach involving social, psychological, cultural, economic, and aesthetic aspects as well as the physical, chemical, and biological. Traditional disciplinary boundaries are becoming blurred, and often times, traditional subjects are less separate bodies of knowledge than they are different ways of looking at things. Studies are merging into an environmental interdisciplinary approach composed of two realms: Environmental System Design-- large or aggregate system, and unit or detail design;and Environmental Management and Control (see Figure III-6, Relevance Tree, for a conceptualization of this trend). This description serves as an opportunity to explore a reorganization of curricula and courses in terms of professional options. An educational program should replicate this thrust, not at the sacrifice of present departmental/discipline oriented programs, but as a responsive supplement.

SUMMARY

To set the basis for future needs, the student's preparation must recognize the tools and substances of the future solution to problems. He must understand the system, its economics, its data, its processes,



(*Test Course)

Figure III-6, RELEVANCE TREE

goals, socio-economic impacts, measures of effectiveness, interactions, and analytical tools available to him. The Professional Interest Focus chart (Figure III-7) is a graphic representation of problem-solving methodology and shows how the elements of many disciplines and specialties are brought to bear on a specific problem. (This chart is not intended to be all inclusive or necessarily representative of the relative position of various functions, but only presents, in a simplified and orderly fashion, an extremely complex combination of human activities.

An environmental systems manager-engineer stands in a unique position relative to national (and global) problems facing mankind because he is fundamentally concerned with each of the issues of pollution, population, resource and energy use, and quality of life. The training of such people to deal with these complex concerns requires a new approach to the educational experience. Perhaps the time is past when traditional lectures using conventional texts cast in the arbitrary administrative divisions of semesters and quarters can provide the kind of education needed to solve the critical environmental problems which lie ahead.

Curriculum

The following curriculum guidelines are suggested:

1. Paracurriculum educational factors should be carefully considered for inclusion wherever feasible in curriculum planning decisions.
2. Curriculum planning should revolve around the basic tasks of education--transmission of values and know-how. The ends must not be obscured by the means.

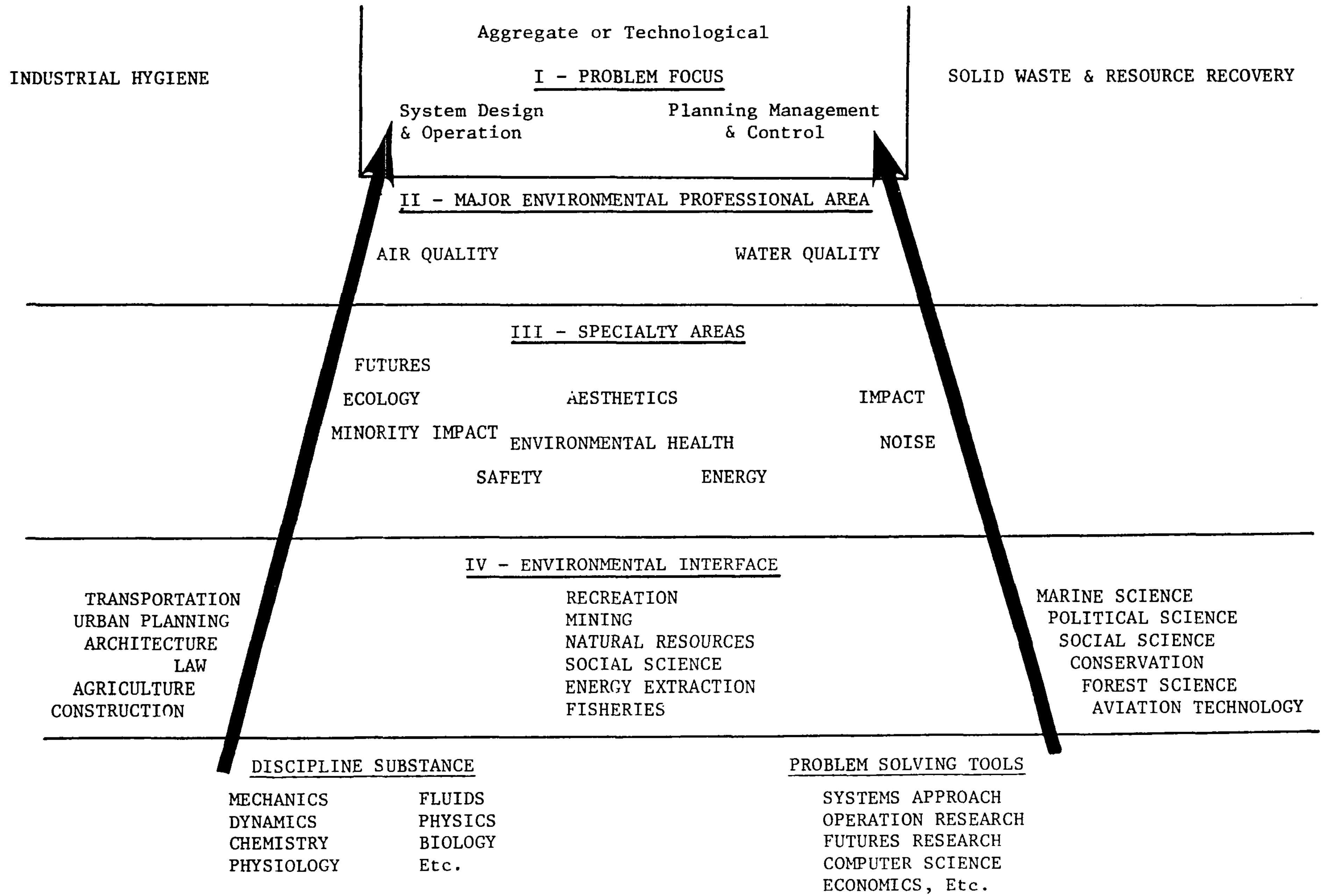


Figure III-7, PROFESSIONAL INTEREST FOCUS

3. The characteristics, needs, motivations, and capabilities of the person transiting the program must be considered in the light of desired graduate capabilities.
4. Curriculum planning should be founded in a continuously developing and responsive set of goals reflecting education for anticipated future needs.

Provisions

The curriculum should provide elements for:

1. Functional breadth as well as categorical depth of special interest to the student along with the inter-disciplinary systems approach and should allow for appropriate "boxing" of courses according to professional options.
2. Engineering systems approach and the fundamental elements of the design process.
3. Integrative humanities leading to clarification of fundamental convictions as a basis for value formulation.
4. Studies relating to a higher sense of professional responsibility.
5. The promotion of exchange between engineering practitioners, interdepartmental academic staff, and non-technological students.

Graduate Capabilities

The graduate of the training program should:

1. Be capable of describing and analyzing environmental systems to predict impacts of growth and development in

advance of design on the total system and be capable and willing to communicate effectively to persons of other professions and the non-professional public.

2. Understand and be willing to synthesize professional activities in an interdisciplinary fashion in formulating viable alternative problem solutions. This includes an awareness and respect for a variety of disciplinary viewpoints and values and a capability of handling interactions and tradeoffs in an acceptable manner.
3. Understand the roles and responsibilities of the profession in the social, political, and ecological contexts.
4. Be prepared for a world of change and career of responsible decision-making (Rosenstein:I-5).
5. Function in operation, management, design, investigation, or planning in such categories as water, air, noise, pollution, and liquid and solid wastes.
6. Recognize the urban system, its economics, data, goals and alternatives, components and arrangements, measures of effectiveness, forecasting futures, interfaces, and analytical tools available.

CHAPTER IV

A PROGRAM

INTRODUCTION

This chapter presents a suggested program in conformity with the preceding rationale and recommendations. An educational philosophy is delineated by a set of statements reflecting educational truths, the overall purpose of the program, and its major characteristics. The program description includes a curriculum framework which forms the basis for developing multiple curricula based on professional options. Course descriptions contain information relative to course purpose, subject matter, presentation techniques, and other pertinent data. In the final section, recommendations for further study are presented.

The suggested program differs from existing engineering education programs in the following ways: (see also Table IV-1)

1. The program attempts to promote integrated humanistic studies with technical environmental studies, encourage and facilitate an interdisciplinary approach, and develop student involvement in the fabric of environmental problems.
2. It presents a unified exposure to common elements of environmental concerns prior to detailed application in particular areas of interest.

Characteristics of Current Programs	Desired Characteristics of Proposed Program
Past- and present-bound.	Focused toward future needs of society.
Environmental problems are approached by reduction into isolated engineering specialties, e.g., air pollution, water chemistry, etc, apparently without conceptual integration.	Approach to environmental problems involves an initial broad exposure to environmental concerns and basic principles while addressing specialties by professional options later in the program.
Minimizes humanistic studies and treats elective options as necessary evil without any particular meaning or direction.	Integration of humanistic studies along with technical specialties which help to give direction and meaning to all studies.
Courses too complicated for the non-technologist thereby discouraging cross campus participation and interdisciplinary interaction.	Present environmental considerations in such a manner to encourage interaction without heavy emphasis on science and technology.

Table IV-1, PROGRAM COMPARISONS

3. It suggests new courses designed to help acquaint the non-technologist with the major problems of the environment and society.
4. The art of engineering is explored by encouraging creativity, sensitivity, and responsibility.

EDUCATIONAL PHILOSOPHY

In light of the discussions in previous chapters, the following statements are presented as the educational philosophy of the program.

1. The educational experience should contribute to a concept of a seamless lifetime continuum of educational opportunity.
2. The charge of engineering is embodied in the Systems Approach (Professional Method) and contains substance and tools toward analysis, synthesis, design, and implementation.
3. Specialized technical or scientific elements of a program should be taught by specialists in that area: chemistry by chemists, biology by biologists, etc.
4. There should be opportunity for interdisciplinary group and individual action as well as multi-professional activity for both students and faculty.
5. Exposure should be graded and balanced involving core, specialty, and elective elements to develop a facility for dealing with special problems as they arise.
6. Academic resources should be sufficiently extensive to

enable students to plan flexibly in a variety of specializations and in response to anticipated concerns of society, the profession, and the student.

7. Technical studies should be integrated with social concerns relative to values, fundamental convictions, and professional responsibility.
8. Educational goals should be continuously redefined according to projected future needs of society, the profession, and the student.
9. The program should be open to all potential enrollees and policies adopted which facilitate entry and exit.
10. Curricula should be rigid enough to provide stability but flexible enough to adapt to change by readily incorporating new knowledge and technology as they become available.
11. Education should be directed at helping the student recognize and wisely select among alternative futures, develop skills for implementing those futures, develop realism in choice, and become energetic in working toward a viable society (Shane:58).
12. Emphasis should be on expressing oneself on the intellectual, emotional, social, and professional planes in addition to knowing how and where to obtain information.

Table IV-2 illustrates how some of these philosophies are implemented in the program.

Educational Philosophy	LINKS	Proposed Program
Contribute to a seamless educational continuum.		Encourages and promotes open enrollment by minimizing prerequisites and facilitates participation by people in all walks of life.
Specialty areas taught by specialists.		Teaching partnership role concept developed and implemented through a senior partner.
Opportunity for interdisciplinary interaction.		Environmental subjects of concern viewed from viewpoints other than from a single discipline, and by encouraging participation by many disciplines across campus.
Graded exposure.		Accomplished through curriculum framework and course development.
Integrate technical studies with social concerns.		Undertakes studies which lead to value clairification and exploration along with professional responsibilities; recognizing and defining relationships between society and the assessment of technology.
Maintain academic responsiveness; program that is stable, but flexible.		Informational feedback system designed to detect changing future needs of the student, the profession, and society
Recognize alternative futures and work toward a viable society.		Futures studies and exercises in technological forecasting.

Table IV-2, PROGRAM LINKAGES

PROGRAM DESCRIPTION

General

Engineering pertaining to environmental systems may be described as the art of applying scientific and technological knowledge to natural and man-made surroundings to the total human environment for the promotion and protection of the health, welfare, and well-being of mankind. This program is directed to the training of talented people for the practice of engineering with the necessary skills, knowledge, and commitment to professionally deal with environmental problems of the future and to participate in the larger decision-making processes in the application of technology. The objective of the course work is analytical insight coupled with professional competence. The graduate might fill positions with consulting, governmental, regulatory, monitoring, or private industrial organizations.

Graduate study in the program may lead to the Master of Science degree according to the requirements and approval of the individual institution and may involve student responsibility for areas of knowledge rather than accumulating a fixed number of credit hours. A final oral comprehensive review of program studies is encouraged. All program elements have open enrollment so that a platform may be realized to open and encourage interdisciplinary dialogue and interaction among components of the institution and the local community. Opportune scheduling (late afternoon or early evening) can facilitate attendance by fully employed people and to reach more of the public over a wider age range. In addition, a program may be developed by selected topical contents with focus provided by the instructor and/or students for special mini-courses.

Length of Training

The program may be completed (minimum requirements for a degree) in approximately 12 study months (three semester equivalents, or one to one and one-half years) depending on background preparation.

CURRICULUM STRUCTURE

General

The curriculum foundation is primarily predicated on an accredited Bachelor's Degree (preferably engineering) composed of basic subjects including English, Literature, Social and Natural Science, Chemistry, Physics, Statistics, Hydraulics, Mechanics, and others. These subjects serve as a foundation for the advanced subjects of environmental concerns such as water and wastewater treatment, air quality management, environmental sanitation, and others.

Students with different preparation may be required to complete remedial work according to the recommendations and arrangements of a counselor or course instructor. Students with advanced preparation may devote more attention to advanced work in their area of interests according to the suggestions of the counselor. Special topics can be studied on a tutorial basis with prior approval on the basis of the relationship of the intended special topic to the student's entire study program.

Since the complexities of the panorama of environmental concerns are far too great for a single-purpose program of study, the tri-graded exposure is directed toward three areas of concern: the aggregate model, planning, large system modeling of engineering processes; technical models of unit processes; and the management systems.

Three semester equivalents are structured as follows: (Figure IV-1) One semester equivalent consists of broad core studies to provide a unitizing foundation applicable to all three areas of concern. Three courses deal with environmental factors such as the urban system, environmental measurements (effects and indicators), and futures studies relative to water resources. A fourth course deals with professional roles and responsibilities.

Another semester equivalent would be devoted to specialty areas. Students who expect to practice in the aggregate or large-scale systems would study technological forecasting, resource systems, and support systems. The unit process engineer would spend most of the time in more detailed studies in a particular field; e.g., the development of water treatment plants along with informational processes that are associated with this. Persons concerned with management would study field examination, acquisition of stream pollution data, stream surveys, and the problems in the running and modification of water plants. Attention would be directed to the problems in official agencies which involve renewal, setting, and passing of specifications as well as the problems associated with personnel arrangements.

A final semester would be devoted to individual/group studies involving real world problems. For example, the large systems engineer might investigate an environmental assessment of a highway surrounding the natural and human environment. The process design specialist could investigate the development of a water treatment facility or industrial waste treatment processes. Management students could look at the problems of acquisition of environmental data or environmental

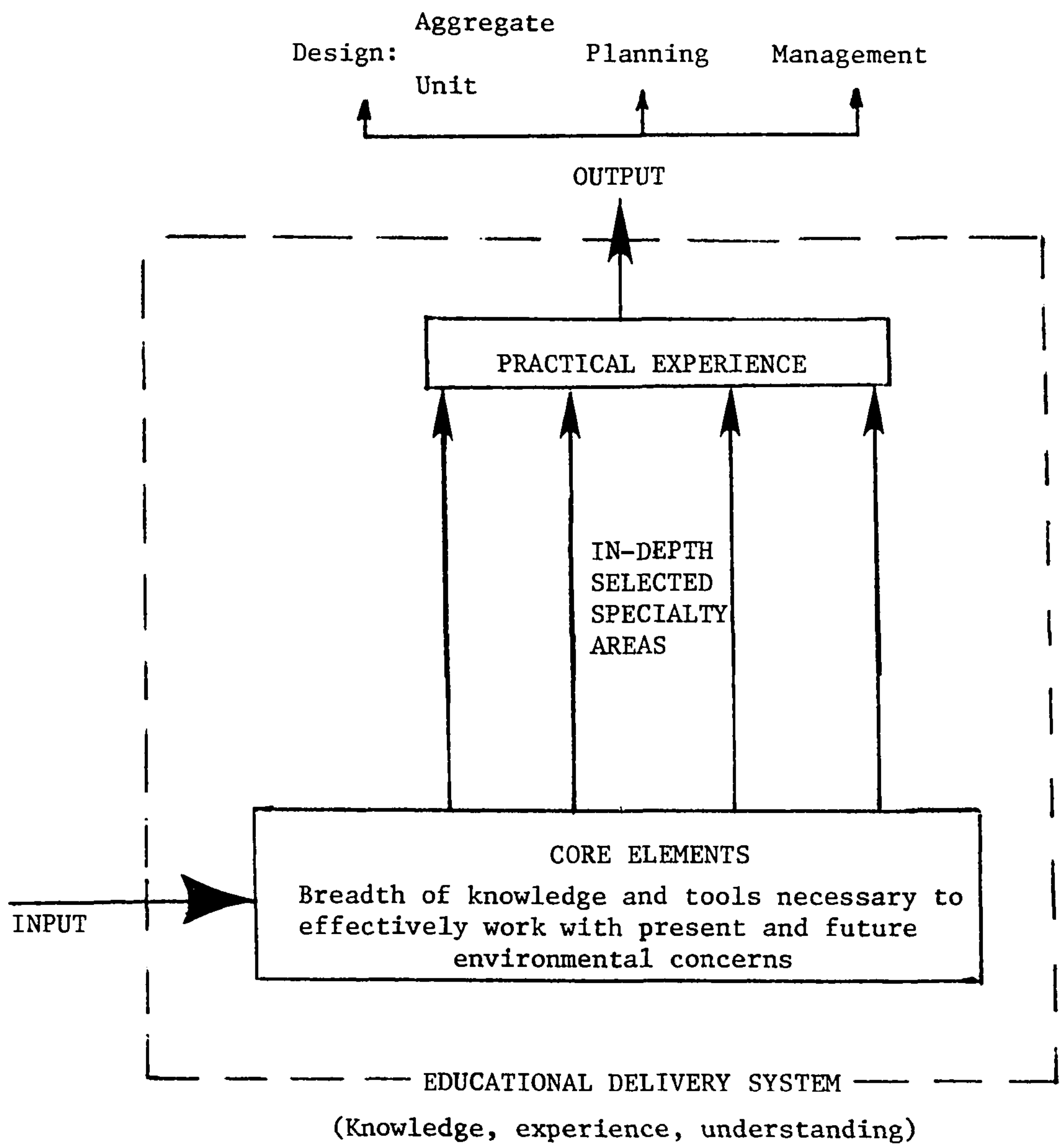


Figure IV-1, CURRICULUM STRUCTURE

inventory analysis for an agency.

A summary report or similar instrument would culminate the student's work and be appropriately credited. Wherever possible, strong and active cooperation with industry, governmental agencies, and private enterprise is encouraged.

An important aspect of this program is that "humanities and electives" are not thrown in indiscriminately. Two core courses are devoted to specific studies which try to integrate all studies to the real world through futures studies, value exploration, and concepts of work relative to life goals. The curricula and courses may be developed into a system of learning modules which allow the instructor to use a variety of instructional strategies and focus learning toward specific learning goals or areas of interest.

Objectives

The overall objectives of the program may be stated as follows:

1. To provide the highest quality of scientific and technologic education to aid in the understanding of the environment so that human activities are directed in concert with the environment to promote the health and well-being of mankind.
2. To develop a capability and motivation for continual self-education and personal lifetime expansion and development.
3. To create an awareness of and critical appreciation for some fundamental concepts and methods employed in environmental studies including social, political, and

ecological perspectives.

4. To provide its graduates with a life-long scheme whereby they can cope with the problems of society in an engineering sense, defined as evaluation, synthesis, design, and implementation.
5. To provide the graduate with the tools and attitudes to make them productive in the future, especially in relation to the rational use of technology for the betterment of mankind, assessment of impacts of technology in advance of decision, and social ramifications.

COURSE DESCRIPTIONS

General

Graduate course work in environmental systems emphasizes a grasp of the principles on which engineering concerning environmental systems is based. The course work is an extension of undergraduate work in depth and breadth. Grading policies and systems may be determined by the local unit but should be de-emphasized. Formal examinations which occupy course presentation time are discouraged. The instructor may record specific performance parameters to justify grades (such as short quiz responses, dialogue participation, etc), but final grades may be generalized; e.g., distinguished, acceptable, not acceptable.

Individual programs of study are synthesized to take into consideration the student's academic or professional background, interests, and ultimate goals. Courses are selected for the development of comprehension of problems in environmental systems and for the mastery of techniques for problem solution. Course selections may also be governed by choice of research topic, special intersts, training-with-industry, or sources of financial support. Specialty areas of study are directed toward the acquisition of entry level job skills regardless of the area of entry into the job market.

Counseling

Course work will be programmed by the student and a faculty counselor. Personal interviews will be conducted during which certain factors will be ascertained: student statements of study objectives (why the student desires to pursue graduate study, post-study intentions, etc.) and student academic and professional preparation, background, and interests. The student will receive full and complete information concerning an explanation of the program, philosophies, objectives, specific work required, remedial requirements, if any, and other pertinent data. Admission to graduate school, if required, will be in accordance with standing policies of the local unit; e.g., letters of recommendation, GRE, GPA, etc. Financial assistance programs should be encouraged, utilized, and integrated into a plan of study to maximize and extend the learning situation.

CORE COURSES - PRINCIPLES

URBAN ENVIRONMENTAL SYSTEMS

Need

A large portion of all engineers are involved with work that has environmental impact on many aspects of human activities on urban and regional areas. Traditionally, they have been interested only in the separate parts of the total system such as highways, streets, water supply, transportation, or structures. This is a unique course offering of an interdisciplinary nature on the subject of the total urban system. The form of an urban system, its growth, its physical components, costs, benefits, measures of the environment of urban systems, and the assessments of impacts of growth on environmental resources are covered. Subject areas include environmental measurements, data forecasting, and system modeling. Technical models of urban areas and their needs relative to housing, transportation, air pollution, water and waste water, drainage, and solid waste are examined along with the use of data output.

Purpose

The purpose of this course is to provide a means of integrating the interacting elements of an urban system for an audience with a background in planning, design, engineering, or related fields and to provide each student the opportunity to examine ones knowledge within the context of the total system. The course will serve to expand the student's appreciation of the integral parts which comprise the urban environment and present research tools for future work.

Facilities

Required facilities include a meeting area or classroom with view-graph or slide projection equipment and possible remote terminal for computer tie-in if gaming is employed.

Presentation Techniques

Duration of the course is 45-60 clock hours depending on the desired scope and extent of coverage. The use of informal dialogue is recommended along with presentations by guest speakers from the local area discussing local problems. Case studies, simulation gaming, and role playing could also be effectively employed. Blocking would serve intersession or special topic presentation requirements.

Staffing

One FTE senior partner; utilize resources from the public service sector, engineering practitioners, and consultants, to describe actual urban problems and solutions.

Prerequisites

None. The course may serve all campus, graduate credit or non-credit, and needs of continuing education. Participants may include faculty, industry, business, or civil service.

Terminal Behavior

The student should be able to describe, either written or orally, the major elements of an urban system along with their interactions and impacts and be able to discuss social components of engineering activities.

Topical Outline

Suggested course subject areas are as follows:

- Principles of Systems
- Implications and Limits of Growth
- Urban Form and Components
- Land Use Principles and Techniques
- Planning/Gaming
- Social System Models
  - Health care delivery
  - Criminal justice
  - Emergency systems
- Urban Technical Modeling
  - Population
  - Housing

Water supply
Solid waste
Drainage
Waste water
Air pollution
Transportation

References

Typical course references may include the following:

Forrester, J.W. "Principles of Systems"
Howard, E. "Garden Cities of Tomorrow"
Mumford, L. "The City in History"
McHarg, Ian L. "Design With Nature"
Meadows, et al, "Limits to Growth"
Reid, G.W. et al, "An Urban Model for the Evaluation of Alternative Growth Policies"

ENVIRONMENTAL MEASUREMENTS

Need

To be prepared for future tasks involving water, air, and solid wastes as they are impacted on by the residuals of man's activities, the engineer needs to recognize, understand, and be familiar with some of the measuring, evaluative, and analytical tools available relative to the physical, biological, and behavioral components of the biosphere. These include ecological cycles, environmental effects, and indicator mechanisms.

Purpose

The purpose of this course is to present the use of general chemistry and biology in the basic analytical and measurement techniques of water, air, waste water, and solid waste; organic and inorganic constituents of these elements. Attention is also directed to the morphology and metabolism of organisms and indicator organisms involved in water, waste water, air, and solid wastes; taxonomic relationships; as well as disease and nuisance producing organisms peculiar to these elements; and to allow each student to examine some of these factors in the laboratory.

Facilities Required

Meeting area or classroom with view-graph or slide projection capability; laboratory equipment for experiments. (Detailed listing of equipment would be drawn up by the local unit and instructor.)

Presentation Techniques

Sixty (60) clock hours, approximately equally divided between chemistry portion and biological portion; dialogue, lecture, TV, case studies, field exercises, lab experiments. (Blocking techniques are not recommended due to the level of technical and scientific treatment.)

Staffing

Department chairman to act as senior partner and program coordinator; ½ FTE, environmental chemist; ½ FTE, environmental biologist; Community representatives (e.g. water plant chemist, biologist or operator) on an opportune basis.

Prerequisites

None. Serves all campus, credit/non-credit; permission of instructor relative to knowledge of chemistry and biology, remedial work acceptable

Terminal Behavior

Be able to describe the analysis and presentation of the environmental media either written or orally. (Formal examination is discouraged; method of grade determination not to detract from presentation time.)

Topical Outline

Suggested course subject areas are as follows:

Topical Outline

Chemistry--30 hours, classroom and laboratory.

Properties and characteristics of physical environments: water, waste water, air, and solid wastes.
Air Pollutants: gases, vapors, particulates, and others.
Chemical reactions: photochemical, oxidation, reduction, and decomposition.
Chemical compounds having adverse effects on human health.
Water Pollutants: oxygen-demanding wastes, nutrient cycles (N, P, Fe, Mn), organic and inorganic chemicals; changes in water quality as a result of man's activities: impoundments, irrigation, land transformation, etc.
Characteristics of solid wastes; potential chemical reactions and physical actions resulting in health and occupational hazards (leaching, washout, vaporization, solubility, etc).

Laboratory work directed to measuring and quantifying: water quality indicators (pH, D.O., C.O.D., N., P., coagulation); air quality indicators (opacity, particulates, gases, fine particulates, transportation and dispersion).

Biology--30 hours, classroom and laboratory.

Properties and characteristics of physical environments; water, waste water, air, and solid wastes.
Indicator organisms: characteristics, detection, significance.
Taxonomy of organisms: morphology, physiology, enzymology, metabolism, biological oxygen-demanding organisms.
Air borne diseases.
Water borne diseases.
Application of biological principles to waste treatments: sewage, industrial wastes, solid wastes.
Biological stabilization of solid wastes.
Disease vectors in solid wastes as well as pathologic and radioactive potentials.

Laboratory work directed to measuring and quantifying: sources of bacteria found in water, air.
Microscopic examination of water, algae, B.O.D.
Taste and odor bioassay.
Purification techniques (chorination, ultrasonic, etc.)
Airborne biological organisms; methods of removal, neutralization.

References

Typical references may include:

Bach, Wilfrid. "Atmospheric Pollution".
Bond, R.G. et al (eds.) "Handbook of Env. Control. Vol 1: Air Pollution".
Enviro Control Inc, "National Assessment of Trends in Water Quality".

References (cont)

"Standard Methods of the Examination of Water and Wastewater", 13th edition, prepared and published by: APHA, AWWA, WPCF.
McKinney, R.E., "Microbiology for Sanitary Engineers"
Lind, O.T., "Handbook of Common Methods in Limnology"
Schwoerbel, "Methods of Hydrobiology (Fresh-water Biology)"

FUTURES AND ENGINEERING

Need

Many environmental studies programs are past- and present-bound while social reality is changing more rapidly than the educational images of that reality. There is a need for persons familiar with the techniques of dealing with uncertainty through the concept of alternative futures by examining trends, developments and events which determine the future. Curricula should offer experiences in creative and speculative uses of the intellect as well as analytical uses in order to promote the integration of learning and living. "The direction of the future of man is controlled by his vision of the future; he is prone to do what he conceives he can do." (Mood:103)

Purpose

The purposes of this course are:

1. To introduce future consciousness into engineering.
2. To promote the use of the future as an integrating device for academic studies and professional activities.
3. To present ways and methods of probing the range of possible futures and relate professional activities with foreshadows of important problems revealed by futures studies.

4. To help the student function, cope, and grow in a high-change society.
5. To stimulate creativity and sensitivity.
6. To help clarify values and fundamental convictions.

In the Appendix of "Learning For Tomorrow: The Role of the Future in Education", p 351f, Rojas and Eldredge list common futures studies course objectives as follows:

1. Help students to anticipate change, i.e., make better career choices, develop future-oriented attitudes, contribute to personal growth, etc.
2. Survey forecasting methods.
3. Develop ability to relate ideas and information between disciplines, and between institutions.
4. Facilitate student-student and student-teacher group interaction.
5. Recognize the continuing impact of technology upon society.
6. Develop ability to evaluate forecasts and utilize feedback in doing so.
7. Study major trends shaping the future.
8. Explore ideas, images, models of the future.
9. Examine case-study forecasts in specific problem areas.
10. Develop alternative scenarios of the future.

Facilities Required

Meeting area; perhaps film review facility.

Presentation Techniques

45-60 clock hours, dialogue, tutorial, brainstorming, independent study, films, writing assignments, role playing, blocking.

Staffing

One FTE senior partner; guest speakers; people who have studied and are familiar with futures studies.

Prerequisites

None, open enrollment, all campus; credit/non-credit; especially adaptable for continuing education, faculty, administration, business.

Terminal Behavior

To be determined at the local unit.

Topical Outline

Dealing with technological change
The time-line
Futures studies methods
Change (rate of, economic, technological)
Alternative futures
Attitudes toward futures
Causality of futures
New values and futures
Transportation and communication in the future
Transcendental change
Stability
Future: crime, weather control, public policy.
Papers:
- Outline plan for life as seen now.
  - include: long-term objectives
    - strategies
    - intermediate-term goals
    - specific action programs
- What kind of society would student like to live in 20 years from now.

References

Toffler, A., editor, "Learning For Tomorrow"
Laconte, "Teaching Tomorrow Today"
Pawley, "The Private Future"
Miller and Hunt, "ADVENT, Futures Studies and Research Curriculum Guide"
Kahn, "Things To Come"
Kahn and Wiener, "The Year 2000"
Chase, S., "The Most Probable World"

PROFESSIONAL ROLES AND RESPONSIBILITIES

Need

Science and technology in all areas of endeavor need to be redirected toward realistic human needs and human survival on the basis of altered values, fundamental convictions, and concepts of work. The need is for persons capable of and willing to measure and evaluate professional activities in terms of an awareness of the consequences of actions. Professional accountability is called for relative to the present and the long-term future.

Purpose

To provide the student with the opportunity to investigate different philosophies, ideologies, and movements, in an engineering sense, which are striving to redirect science and technology toward human survival without compromising human survival. To allow the student to become aware of assessment techniques of professional roles, activities and responsibilities.

Facilities Required

Meeting place.

Presentation Techniques

45-60 clock hours, dialogue, independent reading, tutorial, case studies, written assignments.

Staffing

One FTE senior partner, guest lecturers from other departments and schools. (Perhaps as high as 50%) e.g. Philosophy, Social Science, Psychology, Arts, History, Law, Psychiatry and Behavioral Sciences, and other concerned schools.

Prerequisites

None. Serves all campus and continuing education.

Terminal Behavior

To be determined at the local unit, but generally in accordance with course purpose. (Perhaps no specific terminal behavior is desired.)

Topical Outline

Concepts which may help to give direction, unification, and meaning to professional education in both the philosophical and practical contexts include:

1. Metaphysical analysis, clarify fundamental convictions (Schumacher); reappraisal of innermost values (Fuller, Maslow, Roszak, and others); problems of society not solved by law, government, or technology, but must come from the individual (Schumacher, Bloomfield); value processes of choosing, prizing, affirming, and acting (Kirschenbaum & Simon)

2. Concepts and meaning of work - shift from income orientation to personal satisfaction or social benefit (Mood:85); Buddhist description of functions of work (Schumacher:51; Toffler:xxvi); relationship to goals of life (Schumacher, Maslow, Bloomfield) and societal goals.

3. SCI, Science of Creative Intelligence (Bloomfield:225), proposes knowledge structured in consciousness, higher levels of consciousness results in increased ability to learn and interrelate knowledge from various fields; investigates individual human needs.

4. Historicity, systems approach, and relativity. (UNESCO)

5. More For Less. (Fuller)

6. Technology on a human scale:

Low Impact Technology		
Alternative	"	
Intermediate	"	(Schumacher)
Soft	"	
Humane	"	
Applied	"	(Schumacher)
Eco	"	(Bookchin)
Bio	"	(Clarke)
Careful	"	(Bolton Institute)
Survival	"	

7. "Mount Carmel Declaration on Technology and Moral Responsibility", adopted by participants in the International Symposium on Ethics

in an Age of Pervasive Technology, Technion-Israel Institute of Technology, Haifa, December 25, 1974.

8. The limits of technology. (How much is too much?)

9. The Quality of Life concept from the Arlie Conference.

10. Special interest group platforms. (Sierra Club, etc.)

11. The organization of knowledge.

12. Awareness of professional influences/social responsibility.

13. Science and public policy - interdisciplinology.

From Milton, the criteria for ecologically successful design, the technology:

does not destroy, pollute, or deteriorate the natural or human environment.

encourages the retention of natural diversity and the conservation and/or creation of cultural variety.

conserves non-renewable natural resources by: a. the continued use of durable products, b. the re-cycling of organic wastes to biotic systems, c. the re-cycling of inorganic, non-durable products for conversion to useful products.

makes use of continuously and naturally generating sources of energy (wind, solar, etc) with minimum disruption to associated biological systems.

generates products which require little or no maintenance, or for which maintenance is inexpensive and efficient.

would explore the development of small-scale, decentralized, self-sufficient systems and their role in human society.

strives for considerations which result in stabilized population.

should ensure its products are widely available on a regular basis and economically viable.

would be sensitive to employment needs and opportunities.

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Schumacher, E.F., "Small is Beautiful"
Mood, "The Future of Higher Education"
Peter, L.J., "The Peter Plan"
Bloomfield, et al,"TM: Discovering Inner Energy and Overcoming Stress"
Hetman, F., "Society and the Assessment of Technology"
Miller and Hunt, "ADVENT, Futures Studies and Research Curriculum Guide"
Laconte, "Teaching Tomorrow Today"

SPECIALTY COURSES - APPLICATIONS

Design: Systems Approach to Environmental Problems

Information, analysis, evaluation (value measurement), synthesis, design, optimization, implementation; application to environmental planning and design. Role of the art of engineering, including creativity, sensitivity, innovation, and the use of technology. Organization for optimization and optimization by direct search.

Environmental Science and Engineering

Principles and concepts, demography, hydrology of water supply and sewerage systems; concepts of water and waste water treatment, air pollution control, solid waste management; design of systems to control environmental quality relative to assimilative capacity of transport media; dispersion of pollutants in biosphere; environmental effects and indicators; environmental monitoring.

Industrial Hygiene

Recognition, evaluation, and control of occupational health hazards; dust and noxious gases; work place temperatures, noise, radiant energy, lighting, toxic substances; OSHA legislation, concepts, application, compliance.

Environmental Data Analysis

An in-depth coverage of probability, sampling, statistical analysis, decision theory, data norms, goals, standards, all relative to environmental applications.

Economy of Externalities

Costs and benefits beyond economies of scale which ultimately influence design and implementation; social costs and disbenefits are studied relative to engineering costs and benefits; economic systems.

Environmental Resources

A study of the spectrum of resources and resource systems; identification, description, cycles, and how resources are used/abused by human activities; limiting factors and how they effect utilization and pollution. Ocean resources; water resources; land resources; air resource systems.

Environmental Law

The emphasis in this course would be toward implementation - how to accomplish the engineering tasks within the legal framework relative to governmental guidelines, contracts, financial arrangements, adn water resource policy. (Reference: Reitze, "Environmental Law, 2nd edition", North American International, Wash, D.C., 1974)

Energy Systems and Alternatives

Fossil fuels, atomic power, solar, and wind energy; techniques of extraction, conservation programs; national goals and policies, legislation. (Reference: Kash, et al, "Energy Alternatives", Science and Public Policy Program, University of Oklahoma, Norman, OK, 1975.)

Technology Assessment

General climate for science and technology; demand for control of technology; concepts of technology assessment; experiments and development of methodologies; application of technology assessment; problems of technology assessment. (Reference: Hetman, "Society and the Assessment of Technology", OECD, Paris, 1973.)

Limnology

Aquatic ecology; primarily concerned with the interactions between aquatic organisms and their physical and chemical environments.

Control Techniques and Processes

Studies directed toward experimental design, unit operations, and unit processes including media, mechanisms, and methods.

Environmental Planning

Land use planning and regulation; wetlands; stream channelization; transportation; public lands; preservation of rivers; recreation land; physical, social, economic, and public interest determinants of land use. (Reference: Reitze, "Environmental Planning", North American International, Was D.C., 1974.)

Weather and Climate

Study of the composition, vertical divisions, and physical characteristics of the atmosphere; insolation and heat balance; lapse rate and stability; air masses and fronts; circulation of the atmosphere; effects on water resources.

TYPICAL CURRICULA BY SPECIALTY OPTIONS (See Figure IV-2)

Design (aggregate and unit); Planning

A. Water, waste water systems
   Economies of Externalities
   Water and Waste water Treatment
   Design; Systems Approach
   Hydrology

B. Systems and Planning
   Environmental Science and Engineering
   Environmental Law
   Environmental Resources
   Design; Systems Approach

C. Process Design
   Control Techniques and Processes
   Industrial Hygiene
   Sanitary Design
   Water and Waste Water Treatment

D. Environmental Planning
   Environmental Planning
   Technology Assessment
   Environmental Law
   Environmental Resources

Management

A. Water Quality Management
   Environmental Resources

Typical Professional Options ↓ / Curricula Building →	CORE				SPECIALTY APPLICATIONS												
	I	II	III	IV	Design, Anal	Env'l Rescs	Water and Waste Trmt	Energy Alternatives	Air Pollution Control	Solid Waste Systems	Industrial Hygiene	Control Techniques	Sanitary Design	Technology Assmt	Env'l Law	Env'l Plng	Hydrology
Water and Waste Water Systems	X	X	X	X	X		X						X				X
Systems and Planning	X	X	X	X		X		X							X	X	
Process Design	X	X	X	X	X		X					X	X				
Env'l Planning	X	X	X	X		X		X						X		X	
Water Quality	X	X	X	X		X	X					X					X
Air Quality	X	X	X	X		X			X			X			X		
Solid Wastes	X	X	X	X	X			X		X	X						
Land and Water Use	X	X	X	X		X		X							X	X	
Env'l Mgmt	X	X	X	X		X								X	X	X	

I Urban Environmental Systems
II Environmental Measurements
III Futures and Engineering
IV Professional Roles and Responsibilities

Figure IV-2, TYPICAL CURRICULA DEVELOPMENT

Water Quality Management
Environmental Planning
Water and Waste Water Treatment

B. Air Quality Management
    Weather and Climate
    Air Pollution Control Systems
    Environmental Resources
    Environmental Planning

C. Solid and Hazardous Wastes
    Environmental Science and Engineering
    Industrial Hygiene
    Solid Waste Systems Planning
    Hazardous Wastes

D. Land and Water Use
    Environmental Planning
    Environmental Law
    Environmental Resources
    Technology Assessment

PRACTICAL APPLICATIONS - INTERNSHIP

Need

The need is to close the gap between academic studies and the real world by transposing the learning situation to the circumambient society for the benefit of both.

Purpose

To allow students to work on an individual or group problem in design or analysis in a specialty area or professional option. To gain advantage of synthesizing data in an interdisciplinary or multi-professional framework and being obligated to do individual/team work on a real world problem. To promote report preparation and technical writing.

Facilities Required

To be determined at the local unit according to needs.

Presentation Techniques

Co-operation with local governmental and industrial organizations; research project; consulting project; case study report; combined with independent study and research; 60-80 equivalent clock classroom hours.

Staffing

One faculty acting as senior partner and counselor; in close cooperation with outside representative.

Pre-Requisites

None. Serves all campus and continuing education.

Terminal Behavior

To be determined at the local unit in accordance with the nature of the work and student needs. Documentation of work required.

Topical Outline

Determined in consultation between student(s) and counselor.

RECOMMENDATIONS FOR FURTHER WORK

1. An implementation plan should be devised for the systematic implementation of the proposed graduate training program, including use for continuing education courses, adult education, T.V. presentations, and other avenues to the general public.

2. The suggested program of curricula and course descriptions should be evaluated, refined, revised, and used as a guide for other educational programs.

3. A formal feedback system should be designed and implemented which will evaluate information relative to the appropriateness and effectiveness of the program (in concert with companion programs) based on the integrated information of futures studies to continuously develop

a responsive set of goals. (Concentrated student input is encouraged.)

4. Using the suggested program as a guide, an undergraduate program should be developed as a basis for service to the entire university and surrounding community.

5. The redirection of science and technology through various integrating strategies should be explored by all educational institutions including elementary levels with a view to exposing all elements of society to these enlightenments.

6. Further refine and develop humanistic studies for engineers and all students.

7. Design and implement educational evaluation programs (tied into the feedback system) at all levels of education: institution, faculty, courses.

8. "Futurize" entire curriculum.

9. Develop new courses for implementation based on a reorganization of knowledge.

CHAPTER V

SUMMARY AND CONCLUSIONS

STATEMENT OF THE PROBLEM

The future of engineering and the requirement to become a meaningful part of the public decision-making processes in the growth and development of society depends to a great extent on the education of the professional engineer. The charge to the university is to equip its graduates to successfully cope with problems of the future.

The role of the engineer is two-fold: that of providing the technical in-depth solutions (and alternatives) to highly complex and intricate problems on a multi-professional basis, and to actively participate in the larger decision processes in the appropriate and beneficial use of technology without jeopardizing human survival. Professional training must prepare the graduate to anticipate the long-term consequences of his actions. Therefore, the engineer's self image should be future-focused and contain a large component of a social, political, and ecological consciousness and responsibility which would broaden and develop a capability for playing some total decision roles along with the strictly technical roles. While a technological society certainly requires people equipped with specialized skills, the continued progress of society depends on individuals grounded in comprehensive knowledge which enables them to see coherence in, and give direction to, modern life.

HIGHLIGHTS OF STUDY PROCEDURE

The approach to the study of the educational problem reflects a strong emphasis on a fresh look at education and not just accepting conventional terms and ways of doing things. Background information on the professional setting and the educational setting was gathered from a review of the literature of previous studies on curriculum development, curricula in use, and conferences and symposia on the subject. The informational base thus led to the development of a set of statements describing the educational philosophy of the program followed by more specific statements relating to goals and objectives. Once these were delineated, they were interpreted into curriculum structure, courses, and course descriptions. These, in turn, could then be expressed through methodologies of presentation, faculty development, and topical outlines.

The study was based on a concept of a more fluid educational response to the projected changing needs of society, the profession, and the students. The future focused role of the graduate describes the anticipatory concept of curriculum development which is intended to break the incremental approach to educational design characterized by modifying old course content or simply adding new courses.

A single interdisciplinary course (Urban Environmental Systems) was developed and presented to students of varying backgrounds. Attitudinal feedback information from this experience contributed to the development of other courses.

SUMMARY OF IMPORTANT FINDINGS

Although there seems to be a consensus among educators and consumers alike regarding the need for educational reform, apparently there is very little agreement as to the direction, depth, or form of responsive change. There is little doubt that educators themselves must take the initiative for systemic change and work within the system by incremental steps even though the rate of change may be comparatively small.

Of crucial concern is a continuously developing set of goals of education -- goals which express a reasonable assessment of the future problems of society which the graduate will be expected to deal with. An institutionalized system of goal determination is necessary so that changing goals will precipitate responsive, structural, and elemental changes in the educational system. The task of establishing these goals rests with the faculty based on a system of educational evaluation at all levels of the institution, administration, and faculty. An evaluation program structured around a formalized informational feedback system could function as an effective mechanism to synthesize estranged factions of an educational setting including alumni, the profession, community, and educators while contributing to the establishment of communications between isolated disciplines and professions. Extensive participation by students in such a program would assist them in making better educational and career choices. Goal identification also depends on the educator's vision of a pluralistic approach to education and the role a particular program plays in that spectrum as well as its role in a continuum of life-long learning.

The educational experience needs to be: <u>integrated</u> by humanistic and futures studies to help clarify fundamental convictions and values which give meaning and direction to studies and professional activities; <u>interdisciplinary</u>, perhaps by involving many disciplines and professions with central themes such as environmental concerns, science and public policy programs, etc.; and <u>involved</u> with the real problems of society, perhaps through an educational evaluation system. (These are described by Fanning, p 32, as the "chain of I's".)

To properly equip its graduates for the future, faculties must have a knowledge of the social, political, and ecological requirements as well as the traditional interests in the physical sciences and their applications. Faculty growth and the creation of an environment conducive to growth are important. Teaching methodology is of considerable concern because of the advantages realized by matching specific course or elemental objectives with the most favorable methodology under given circumstances and may be adapted to individual learning differences.

Perhaps the single most influential factor in bringing about educational reform will prove to be the economic setting. Reactions to fiscal considerations are immediate at all levels from students and faculty to the university. The rising costs of higher education may tend to force the elimination of redundancy while increasing practicality and revelance because total educational costs will be measured by the worth and benefits of a formal education.

CONCLUSIONS

One of the most important functions of the university is to provide its graduates with a life-long scheme whereby he can cope with the problems of society in an engineering sense which is defined as evaluation, synthesis, design, and implementation. It requires that the faculty themselves develop a continuous process of goal identification and institute responsive changes for curricula and courses. It also requires that a variety of presentation methodologies and techniques be examined and utilized under the most favorable conditions in terms of student needs, faculty capabilities, and institutional resources.

The expanding role of the engineer requires a conscious recognition of the social impacts and influences his (her) activities may carry. The practitioner must understand the ends (social goals) which these means (professional activities) are meant to serve. Personal values and fundamental convictions need to be clarified and understood in order to realize and honor a sense of responsibility above a calculating attitude which refuses to see and value anything that fails to promise an immediate utilitarian advantage. The individual needs to undertake relevant studies (provided for in a curriculum) which will promote a synthesis of values in concert with life goals and concepts of work. This awareness is meant to provide unification, meaning, and direction to the student's studies. This integrative focus also will affect, in turn, future professional activities and influence the eventual service to society in its growth and development.

This study and the resultant program suggests one approach to a pluralistic educational response.

LIST OF REFERENCES

In preparing this report, it was intended to review as much as possible of the truly massive amount of literature pertinent to the study subject. However, the following listing of selected references only includes about one-half of the total items surveyed. Numerous ideas and concepts relating to the educational scene were explored during the course of the study. Gradually these evolved into the main cluster of ideas generally represented in this report. A definite distinction could not always be made between ideas picked up by reading and study, mulling over certain patterns in numerous conversations, or just contemplating about the subject. Nevertheless, an attempt was made to relate specific references wherever possible. Those marked with an asterisk were particularly significant.

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APPENDIX A

Phase I

Course Presentations

"Urban Environmental Systems"

Part I

General Description

The University of Oklahoma School of Civil Engineering and Environmental Science prepared a unique graduate environmental course of an interdisciplinary nature on the subject of urban systems which was presented at OU on May 12 - 23, 1975 and at the University of Arkansas on May 19 - 30, 1975. Topics covered included the: urban form, growth, physical components, costs, and benefits; measurements of the environment of urban systems; and assessments of the impacts of growth on environmental resources. Subject areas included environmental measurements, forecasting, system modeling, and urban planning. Technical models which reflect urban needs were examined in the areas of population, housing, transportation, air pollution, water, wastewater, drainage, and solid waste disposal.

The purpose of the course was to provide a means of integrating the interacting elements of an urban system for an audience with background preparation in planning, public administration, engineering, or other areas of interest within the context of the urban system as a whole. The course was to serve to expand the student's knowledge, appreciation, and consideration of the various integral parts which collectively comprise the urban system. The student could then examine some techniques required for evaluation of impacts of component changes on the whole urban system.

Attendance was open to all students of the university with senior or graduate standing and to interested members of the local community or related fields.

The presentation of the course utilized the technique of the "upside down" curricula (see Chapter II), the lecture method of instruction (LMI), seminar, and practical application involving gaming, simulation, data forecasting via computer models, and land use concepts. This arrangement provided a maximum opportunity for interdisciplinary group and individual action for both students, faculty, and guest lecturers.

The objective of the course was to provide the student with an understanding and description of the urban system in terms of: economics, goals, processes, data, components and arrangements, measures of effectiveness, and alternative futures forecasting. From this exposure, the student was expected to derive a comprehensive understanding of the functions and operations of the urban environmental systems.

Participating University of Oklahoma Faculty and Staff

Professor George W. Reid, Regents Professor and Director, Bureau of Water and Environmental Resources Research.

Mr. Marian Opala, Administrative Director of the Courts, State of Oklahoma.

Dr. Silas Law, Research Associate, Bureau of Water and Environmental Resources Research.

Mr. James O. Dritt, Research Assistant, Bureau of Water and Environmental Resources Research, and Ph.D. Candidate.

Mr. Joseph Lawrence, Teaching Assistant, and Ph.D. Candidate.

Dr. Robert T. Alguire, former doctoral student of Professor Reid, presently with the Business Science Corporation, home offices in Tallahassee, Florida.

Professor Reid initiated the course and provided overall direction to the course while Mr. Dritt provided the necessary day-to-day supervision and coordination. The presentations and instruction by all participants resulted in a highly successful program.

A draft text prepared at the University of Oklahoma was prepared and pertinent chapters were abstracted for use during the various presentations, demonstrations, and consultations. The text is not finished and a great deal of work has yet to be done before a final form is presented. Therefore, it is not included here but will be available at the University of Oklahoma's Bizell Library.

University of Arkansas

A special intersession course (CE 4833 or CE 5633) was established as a means for presenting the course with the cooperation and/or participation of: Dr. Loren Heiple, Dean of Engineering; Dr. E. W. Lafevre, Head of the Department of Civil Engineering; Dr. Hugh Jeffus, Coordinator of Environmental Studies; Dr. James Moore, Assistant Professor of Civil Engineering; personnel of the Division of Continuing Education; and other University of Arkansas officials. Their continuing interest and active participation contributed immeasurably to the success of the course. Overall supervision and conduct of the course was provided by Professor G. W. Reid, principal investigator, and James O. Dritt, research assistant, both of the University of Oklahoma.

Under the concept of the "upside down" method of instruction, the first part of the course was a presentation of the urban growth problems in the "real world" of Benton and Washington counties, northwestern Arkansas. The second part of the course developed a modeling approach leading to alternative solutions to the problems described in the first part of the course. The entire course was tied together by simulation, gaming, forecasting based on manipulation of models through computer programming, and planning seminars. This portion of the course was conducted by Joseph Lawrence, teaching assistant, University of Oklahoma, who was assisted by Dr. James Moore and James Dritt.

The course schedule was carried out as follows (see Table I). Topics discussed by each lecturer are so indicated on the schedule. Excepting the first day, the first week consisted of an attempt to present the real world problems of northwestern Arkansas as expressed by citizens and officials engaged professionally with those particular areas of concern. The guest lecturer's names and affiliations are:

UNIVERSITY OF ARKANSAS

May 19-30, 1975

URBAN ENVIRONMENTAL SYSTEMS
(CE 4833 or 5633)

	Monday-May 19	Tuesday-May 20	Wednesday-May 21	Thursday-May 22	Friday-May 23
9:00	Introduction and Orientation by J. Dritt J. Lawrence	Transportation by K. Riley	Water Supply by H. Jeffus	Solid Waste by J. Moore	Legal System by M. Opala
10:30	Overview: The Urban Scene by G. Reid	Housing by B. Harlan	Water Supply by R. Starr	Sewage by C. Yates	Planning by W. Bonner
12:00	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH
1:00	Urban Systems & Problems by G. Reid	Air Pollution by J. Moore	Wastewater by J. Moore	Drainage by H. Jeffus	Public Health by B. Parette
2:00	Introduction and Orientation	Simulation, Gaming, Forecasting, Computer Operation J. Lawrence, J. Moore, J. Dritt			

TABLE I, COURSE SCHEDULE

TABLE I (CONTINUED)

	Monday- May 26	Tuesday-May 27	Wednesday-May 28	Thursday-May 29	Friday-May 30
9:00	HOLIDAY	Systems Approach by G. Reid	Forecasting Methodology by S. Law	Demand Model by R. Alguire	Area Water Quality Management by V. Mathur
10:30		Goals, Alternatives by G. Reid	Population Model by S. Law	Drainage Model by R. Alguire	Human Systems by G. Reid
12:00		LUNCH	LUNCH	LUNCH	LUNCH
1:00		Modeling by G. Reid	Housing Model by S. Law	Airport Model by R. Alguire	Review and Conclusions by G. Reid, J. Dritt, J. Moore, W. Lafever
2:00	Continuation of First Week Planning Seminars				Summary & Conclusions J. Lawrence

Practitioners

Mr. Kenneth Riley, Director, Northwest Arkansas Regional Planning Commission.

Mr. Bob Harlan, Planning and Housing Coordinator, Northwest Arkansas Planning Commission.

Mr. Richard Starr, Engineer-Manager, Beaver Water District, Lowell, Arkansas.

Mr. Carl Yates, President, McGoodwin, Williams, and Yates Consulting Engineers, Fayetteville, Arkansas.

Mr. Bill Parette, County Sanitarian, Washington County, Arkansas.

These professionals presented outstanding lectures in the areas of their expertise. They were asked to relate the comprehensive problems in their subject and to present their personal views of all aspects including those that relate to real life such as the calibre of people and levels of structure one must work with. The lecturers were successful in this endeavor and proved to be very enlightening. As a result, lively discussions and interactions ensued between lecturers and students, and student to student.

Participating University of Arkansas Faculty

Professor William Bonner, Professor, Department of Community Affairs, College of Arts & Sciences.

Dr. Hugh Jeffus, Associate Professor and Coordinator of Environmental Studies, Department of Civil Engineering.

Dr. James Moore, Assistant Professor, Department of Civil Engineering.

As academic participants active in community affairs of northwestern Arkansas, they also contributed immeasurably to the success of the entire program by presenting urban problems as they are. Their outstanding work is greatly appreciated.

Participating Students

Bercher, Thomas E.O.	Student in Masters of Public Admin
Westerlund, Douglas Webb	Student in Masters of Public Admin
Russell, Harry C.	Candidate for MSCE
Sanguanruang, Sermsak	Candidate for PhD in Engr
Schroeder, Joe Robert	Candidate for MSCE
Tyra, Leo Paul	Owner of private consulting engr. firm
Black, Thomas Oswald	Undergrad CE
DePriest, Darrell	Env. Science Undergrad
Easley, Brad T.	Undergrad CE
Egan, Keith B.	Undergrad Env. Sci.
Emerson, Stanley M.	Undergrad CE
Gordon, John Stanford	Undergrad CE
Jorgensen, Dave	Undergrad CE
Kerr, William D.	Undergrad CE
Raible, Glen A.	Undergrad CE
Songsiridej, Viroj	Undergrad CE
Whitington, Timothy Porter	Undergrad CE

Part II

Course Evaluation

A. Developing the Questionnaire

Before this course was presented, a method of course attitudinal evaluation was needed as a way of determining good and bad points of the course, whether emphasis or de-emphasis of course sections was desirable, or whether adequate time was allotted for the subjects covered. The questionnaire is a product of intensive efforts to derive a form that was brief, yet illuminating, and encouraged critical comment. Several sample questionnaires were reviewed and the best techniques from each were adopted in the final form. One of the most helpful was the form routinely sent out to persons completing course work through the BLS program of the Center for Continuing Education Center here at the University of Oklahoma.

The questionnaire went through developmental iterations. Finally, a trial questionnaire was sent to several instructors for critical evaluation. The resultant final form reflects these critiques of both form and working.

This questionnaire makes no claim to having either scientific or statistical properness. It is believed to provide a good approximation of the way participants as a whole responded to the courses' material and objectives, as well as act as a sounding board for any gripes and/or kudos which the participants felt important.

Evaluation Procedure: (See Questionnaire)

1. Course Organization and Ranking of Sections

Questions pertaining to the organizational qualities of the course are contained in the first section. It contains six questions, with question #6 having parts "a" and "b". Respondents were asked to select one of five responses to each question. The responses were: A-always; B-often; C-sometimes; D-occasionally; E-never.

2. Description of Sections

Respondents were asked to complete four questions dealing with each of understanding the subject matter of each section, the importance of each section, whether coverage of each section should be expanded, reduced or left the same, and asked to list, in order of importance, the three sections most appropriate or applicable to his interests.

a. Methods of Presentation

Students were asked to note which methods of presenting the course material they preferred, in light of just having taken the course.

b. Supplemental Aids

Students were asked to respond to which, if any, supplemental teaching aids they would like to see used in presenting the course.

c. Evaluation

Opinions on preferred methods of evaluation for students taking the course were sought.

d. General Recommendation or Comments

This section sought comments or recommendations for improving the course in material, organization, time, etc. The students were encouraged to criticize the course and make constructive comments.

3. Grouping of Respondents

Respondents were broken down into respective groupings based on the prior level of knowledge each had about the subject matter covered. Also, respondents who were Civil Engineers (CE), Environmental Science (ES) and Environmental Engineering (EE) students were isolated and tabulated separately. This was done to see how the course worked for those at whom it was specifically aimed. In addition, the rest of the respondents (non CE's and ES's) were put in the "other" group for comparison to the CE group.

Part III

Results

A. Course Organization

Responses to question 1, "were objectives clearly stated and followed throughout the course" were usually answered B, often. Responses from CE's did not deviate from the norm.

Question 2, "did the course integrate the related material effectively?", drew a more mixed response, with eight B's, and six in the C and D category. General comments indicate the average rating was a result of confusion to the students from a lack of organization and co-ordinating on the part of the speakers.

Question 3, "did the course emphasize what you perceived as the most important aspects of the material?", received nine B ratings, and even distribution of the remaining seven points between A, C and D.

Question 4, "the topics of the course were timely", drew a wide range of responce, five A's, five B's and six C's, D's and E's. This was a result of some students wanting more detailed coverage of the course subjects.

Question 5, "the topics were important to your job or position" has a mixed rating. Six rated this question A, and six rated it C. The CE group split from the "other"group, by rating the topics much more important. The "other" group felt the topics to be of average imporance.

Question 6 is composed of two parts: (a) "was the course well organized as to content", and (b) was the course well organized as to fluidity of course sections. Part (a), content, was rated B or above by 2/3 or all respondents, with part (b) rated a bit higher. Distribution was evenly spread.

Referring to the summary tables attached, the data shows most students found all sections to be easy to moderately easy. Section 2 and 6 were ranked moderately hard by several persons but not the majority. Section 6 was rated lower than it should have been because of time limitations in working with the models. Section 5, on law, was rated moderately hard to difficult by a third of the respondents. This rating generally was composed of persons with no prior subject knowledge.

All sections were rated by a majority as important concerning subject matter. Section 1, the overview received several remarks from the CE group that it occupied more time than should have been allotted to it.

In voting to expand or reduce sections as to amount of coverage as a group, all sections were deemed worthy of expanded attention except for Section 4, solid wastes. Reducing Section 4 was probably a result of lack of exposure of the students to the problem of solid wastes and a concern on their part of more glamorous areas of inquiry. The CE group desired expansion of all sections except Section 1, while the others wanted expanded coverage of all sections except Section 3.

In practicality, Sections 2 and 3 received most first place votes. Second place was equally spread between Sections 2, 3, 4 and 6. Sections 3 and 6 received most third place votes.

In rating the top three sections as to their practicality or appropriateness to the students, the CE's differed in what they felt was important in comparison to the rest of the class. CE's favored Section 3 for first place, split second place among Sections 2, 3, 4 and 6 and split third place votes between Sections 1 and 5. The "other" group allotted no first place votes to the CE's choice, Section 3. The others favored Section 6 for second place, for which the CE's allotted no votes, and gave third place to Section 3, which the CE's voted first place. The people taking this class differed widely when assessing their choices as to the best units of material presented. That the CE's and people from other disciplines should be so completely out of agreement on this point is indicative of the engineers being programmed to respond to more innovative developments in the engineering field. Of the "others", most were taking the class as an introduction, a brief look at the tools of the trade of an unfamiliar discipline. This can possibly explain their differences in preference.

Overall, students with civil engineering or related backgrounds were reasonably well satisfied with the class as presented. Outside of time limitations on gaming and modeling, and the repetition by some speakers, the course as a whole was successful. Recommendations for future efforts to present this course should include (1) allotting more time for subjects or presenting less material, (2) extending particulars in modeling and gaming and less coverage in the overview, legal and solid waste sections. Another way to make the course proceed more efficiently would be to mail a reference list to students prior to the course being presented. This would allow those with great interest to become familiar with terms and concepts that are to be elaborated on in presentation.

Generalized comments show many respondents somewhat uncomfortable with the upside-down presentation of the course. This feeling was not shared by a majority of the students and was disconcerting only to a few. Some complained about the inability to question speakers in detail on subjects the students had no technical knowledge about, expecially the models. People who criticized use of this technique felt at a loss to formulate meaningful questions. In response to this, a reference list, mailed out prior to the course, could help alleviate the problem.

Judging from the basic uniformity of class response, it can be concluded the diversity of the group presented few problems to the course. The group of non civil engineering students felt the course and its parts were as beneficial to them as the civil engineering students did. However, if the course were to go into more technical depth, as the CE's would like, it may reduce the effectiveness of the course for students of other disciplines.

B. Method of Presentation

Thirteen people favored the method of presentation for material used for this course, i.e., the lecture method of instruction (LMI).

Ten people felt panel or group discussions would be a good method, but usually only as a supplement to LMI.

Nine people thought case studies over the subjects covered would be advantageous. This method was seen as a supplemental tool with LMI.

Six people favored problem oriented learning sessions, five liked an assigned readings format, and only four chose a compacted presentation, similar to what they were receiving.

C. Supplemental Teaching Aids

Twelve persons favored more use of pictures, slides and illustrative material to enhance understanding in the learning situation.

Field trip and study question and topics were felt to be helpful by five persons, and films and lab demonstrations were favored by only three and two persons, respectively.

D. Evaluation

The majority of respondents felt a course of this type was not suitable for evaluation, nor was it necessary. No other evaluation procedure received over two votes as being necessary.

E. Comments

General comments over the whole course and specific criticisms over sections presentation, etc., were solicited. Certain comments were repeated often enough to indicate widespread agreement between the students taking the course.

The most frequently repeated comments were that there was too little time for becoming acquainted with the models, and that the course was too compressed, time wise, for the amount of information presented.

The next most often repeated comment was a lack of organization in course presentation. This took several forms. Many people said, especially as pertained to the modeling, that speakers did not seem to be aware of what material the speakers before them had covered. This led to a repeated rehash of the same material.

Several people needed better explanation of the models, how they are constructed and what to do with them. The models seemed to attract a great deal of interest but were not adequately covered to satisfy the students.

Many desired greater attention to details and less generalization. This was a widespread attitude among civil engineering students and those associated with civil engineering. They also felt less of a need for sociological, economic or philosophical considerations than did other respondents. This is a prevailing attitude among engineering students.

Part IV

Conclusions

A. The objectives of the course were met as originally set forth. It provided for the presentation of interacting systems that constitute an urban environment.

B. The course content proved to be relevant to the needs of those taking the course, and timely as to the currency of information provided.

C. The use of an interdisciplinary team approach in presenting the course was successful. Guest lecturers representing different disciplines in urban systems were able to present a panarama that provided valuable insights into urban problems from several different viewpoints.

D. The time frame scheduled to present the course (nine days) was generally unsatisfactory to the students. The best remedy would be to extend the time allowance for course presentation. This would permit more student-instructor interaction and a less hurried learning situation.

E. The use of an upside-down approach to course presentation was found to present problems to those unaccustomed to different approaches to learning situations. In the overall review, use of the upside down approach as a teaching technique had no pronounced advantage over conventional techniques, although it did show some negative results. It is a useful tool when used in a program that covers extended periods of time, such as a full semester course. But use of this technique in a course of limted duration, especially where the students are not likely to have seen it used before, not are likely to see it used again, probably does more harm than good.

COURSE ORGANIZATION

Respondent Category	Evaluation	Question Number 1	2	3	4	5	6a	6b
(2)	A	1	1			1	1	1
Quite a bit of prior	B			1	1			
knowledge	C	1	1					
	D			1	1	1	1	1
	E							
(11)	A		2	3	4	4	2	1
Some prior knowledge	B	8	6	5	3	3	6	6
	C	2	2	2	2	4	2	4
	D	1	1	1	1		1	
	E							
(4)	A	1			1	1	1	
No prior knowledge	B	2	2	3	1	1	1	4
	C		1	1	1	2	2	
	D	1	1					
	E				1			
Civil Engineering	A	2	2	2	2	5	3	2
Environmental Science	B	7	5	6	2	3	4	5
Env'l Engineering	C	1	3	1	3	2	2	3
(11)	D	1	1	2	2	1	2	1
	E				1			
(6)	A		1	1	3	1	1	
Other	B	3	3	3	3	1	3	5
	C	2	1	2		4	2	1
	D	1	1					
	E							
(17)	A	2	3	3	5	6	4	2
Total	B	10	8	9	5	4	7	10
	C	3	4	3	3	6	4	4
	D	2	2	2	2	1	2	1
	E				1			

EASE OR DIFFICULTY OF UNDERSTANDING

Respondent Catagory	Evaluation	Course Sections 1	2	3	4	5	6
(2) Quite a bit	E	1		2	2		
	ME	1				1	
	MH		2			1	1
	D						
(11) Some	E	6	2	5	3	2	2
	ME	3	4	6	8	5	5
	MH	2	5			1	4
	D					1	
(4) None	E	2	1	1	1		
	ME	2	1	2	3	2	2
	MH		1	1		1	2
	D		1			1	
(11) Civil Engineering Environmental Science Env'l Engineering	E	5	1	5	4		1
	ME	5	3	5	7	8	5
	MH	1	6	1		3	4
	D		1				
(6) Other	E	4	2	3	2	2	1
	ME	1	2	3	4		2
	MH	1	2				3
	D					2	
Total	E	9	3	8	6	2	2
	ME	6	5	8	11	8	7
	MH	2	8	1		3	7
	D					2	

SECTION PRACTICALITY

Respondent Catagory	Evaluation	Course Sections 1	2	3	4	5	6
Quite a Bit	First			2			
	Second	1			1		
	Third		1				1
Some	1	3	5	3			
	2		2	2	3		4
	3		2	5	1		3
None	1	1	2	1			
	2		2	2			1
	3	1		1	1		
Civil Engineering	1	1	4	6			
	2	1	3	3	4		
	3		2	2	2		5
Other	1	3	3				
	2		1	1			4
	3	1	1	4			
Totals	1	4	7	6			
	2	1	4	4	4		4
	3	2	3	6	2		5

SHOULD COVERAGE BE EXPANDED OR REDUCED

Respondent Catagory	Evaluation	Course Sections 1	2	3	4	5	6
Quite a Bit	Expand	1		1	1		
	Leave		1	1	1	1	1
	Reduce	1					
Some	E	2	6	1	2	6	6
	L	5	4	6	6	3	4
	R	3		3	2		
None	E	1	3	3	3	2	3
	L	3				1	
	R						
Civil Engineering	E	2	6	4	4	3	4
	L	4	3	6	6	6	5
	R	4					
Other	E	2	3	1	2	5	5
	L	4	3	2	2		1
	R			3	2		
Totals	E	4	9	5	6	8	9
	L	8	6	8	8	6	6
	R	4		3	2		

SECTION IMPORTANCE

Respondent Catagory	Evaluation	Course Sections 1	2	3	4	5	6
(2) Quite a bit	Important			1	1	1	
	Fairly	1	2	1	1	1	1
	Not So						
	Unimportant	1					
(11) Some	I	5	8	8	7	3	7
	F	4	3	2	3	5	3
	NS	2		1	1	2	1
	Un						
(4) None	I	3	3	3	3	3	3
	F		1	1	1	1	1
	NS	1					
	Un						
(11) Civil Engineering	I	4	5	9	8	5	6
	F	4	6	2	3	5	4
	NS	2				1	
	Un	1					
(6) Other	I	4	6	3	3	2	4
	F	1		2	2	2	1
	NS	1		1	1	1	1
	Un						
(17) Totals	I	8	11	12	11	7	10
	F	5	6	4	5	7	5
	NS	3		1	1	2	1
	Un	1					

RECOMMENDED METHODS OF PRESENTATION

Method	Responses
1. LMI (Lecture Method of Instruction)	13
2. Panel or Group Discussion	10
3. Assigned Readings with Seminar Format	5
4. Compacted Presentation	4
5. Case Studies	9
6. Use of Multi-Media Learning Center with Individualized Instruction	1
7. Problem Oriented Learning Situations	6
8. Uncertain	-
9. Other	1

@@@@@@@@@@@@@@@@

SUPPLEMENTAL TEACHING AIDS

Aids	Responses
1. Pictures, Slides and Other Illustrative Material	12
2. Study Question and Topics	5
3. Films	3
4. Field Trips	5
5. Lab Demonstrations	2
6. Other	-

University of Oklahoma - Intersession -

Evaluation of Peace Corps Municipal Public Works
Intern Program and Urban Systems Course

Submitted by: Gay Adams, Intern Coordinator
University of Oklahoma

From May 12-23, 1975, the Peace Corps Municipal Public Works Interns returned to the Norman Campus, University of Oklahoma, to complete their training. This group included the eight who attended in December and three additional interns who had volunteered during the interim. They were from various universities but primarily from the SALA group.

The following is a list of those who attended and their final dispensation to our knowledge. Followup is difficult except for those students who have written to us.

Intern	Placement Status
Darrel Baker	Morocco
Larry Olsen	Morocco
Steve Liming	Vista - New Mexico
Jonathon Harrison	Trying to be placed with his fiancée
Joan Kane	Application Lost
Kay Carrington	Tunisa
Stuart Rucker	Not Placed
Burton Grubb	Venezuela Cancelled -
F. H. "Trip" Bennett	Dropped
Bruce Hansen	Not eligible until Fall '75
J. W. Dansby	Late Applicant

Recruiting:

Recruiting proved to be difficult in this program. Primarily this was because of the lack of effective communications between PC-Washington and the University recruiters and the recruits. It was especially difficult to gain information about the processing of applications and the status of students within that process. When and if students reached the placement stage, it then became a question of firm placements or of available in-country openings for their particular skills. What was most apparent throughout all of this was the lack of guidelines from PC-Washington and the fact that only through experience could a teaching institution develop the proper procedure of effectively recruiting and training the students.

Decentralization of the application process back to the regional level may bring needed changes if the applicants can be handled more uniformly in a better organized method. Students need to be better informed so that they do not make other plans. This delay in placement resulted in the program's losing some of th. most qualified applicants. Also, when a special program is offered, such as the Urban Systems Course, other recruits may need to be referred into it to increase its effectiveness. If this had occurred in the first year, then the second year recruitment would have been a different situation.

The program being conducted with the Smithsonian Institute where that instutition develops the placement positions for the interns in addition to the recruitment and training of them is ideal. Of course that program is a great deal more expensive than those funded at the other institutions.

Urban Systems Course:

Academically the project was developed and directed toward taking students from various didactic backgrounds and bringing them together, working on a systems approach to urban and environmental problems. Because of the one week exposure in the December Course to the general topic of the urban environment, the second session was focused on the real problems experienced by professionals in their fields.

Initially, the course was planned to follow the "upside down" method of instruction. This was altered later because students could not arrive at the same time because their university terms ended at different times. For this reason an effort was made to always have the guest lecturer or problem presentation before the modeling or problem approach. At the end of each week a session was held to review the objectives, the presentations and to answer any questions that had arisen.

During the second week, an afternoon session was held for four days to allow for playing the taped sessions, which some interns had missed, and to provide additional information outside the framework of the course. This information included community data about Morocco and Venezuela and background information in some subject areas requested by the students.

The class schedule and list of guest speakers and instructors is attached. Handout material was distributed by some speakers, but it is not particularly meaningful without the text of each speech; therefore it is not included in this report. The course in general followed the outline of the Urban Systems Manual submitted in the previous report.

Effectiveness of the Course

Both before the course and at the end of it, the enclosed questionnaires were distributed to the interns. Most of them responded to the preliminary questionnaire. We found it to be very helpful in the planning process to know what each student felt needed to be emphasized and which subjects they were unfamiliar with and needed extra materials on.

The Course Evaluation form was most important in letting us know how each student felt about the instruction and course content. We also were able to correlate differences in training background particularly among the architectural students of which we had a greater number. The Texas Tech graduates, for example, showed the highest degree of social orientation and needed more technical material.

In general, the results showed the following improvements were needed in the course material:

Section 1: The bachelor-level graduates were found to be unprepared for upside-down teaching and were not as adjustable to change in methods as were the established graduate-level students who have since been taught the course. Part of this difficulty could have been due to some students starting later than others, though it was not possible to schedule all students to arrive at the same time and to leave at the same time. The fact that some were uncomfortable with the upside-down method pointed to the need for some additional preparatory material to be made available to them prior to the commencement of the course other than what was included in the course announcement. The student also felt a greater need for more international treatment of problems than is possible based on the present technology. This also seemed to point to a need for preparatory treatment in the form of a section on technology transfer and what specifically might be expected of them in their future positions.

Section 2: Models should be emphasized less for the PC interns. Probably the models need to be handled more as a "hands on" exercise with some participation in a current research problem dealing with surveys, on-site visits, etc.

Sections 3,4,5 and 6: These sections received the most favorable comments with little change suggested. The air pollution section was felt to not be applicable by some.

Generally, the interns were pleased with their experience and had no great difficulty with the material covered. The biggest problem was in initial misconceptions of what we were attempting to do with this course, and what procedures were followed by the Peace Corps during the application and placement process. Many interns had it confused with the in-country training which they had heard so much about.

Finally, interns expressed some need for more social and behavorial emphasis. It was not an aim in this course to prepare the interns for that aspect of their future placement because each culture is different. It was particularly a difficult process to get this across to those students with a sociological background. This was not a problem with the engineers. It was the aim of this course to provide them with skills and methods for a systems approach to future problems so, when confronted by a different cultural orientation, they would be aware of the basic omponents in each system and have some tools with which to work. This aim was well met according to the evaluation.

URBAN SYSTEMS COURSE

PURPOSE -- To offer a course which ties together the interacting elements of an urban system for an audience with a broad background of preparation in one or more of these elements; planning, design, engineering, etc., the purpose of which is to provide each student the opportunity to examine his knowledge within the context of the system as a whole. Thus, it will serve to expand the students' appreciation of the integral parts which comprise the urban environment and provide his with the research tools for future work.

PREPARATION OF AUDIENCE -- The background of the audience will be students from primarily a city, planning, architecture, or engineering preparation with work experience in a planning or management capacity as an acceptable substitute for academic training.

TYPE OF INSTRUCTION -- The Urban System course involves two weeks of lecturers on systems' definitions, national problems, finance, and administration, with the last part of the course devoted to model use on problems of housing, water, drainage, etc. There should be sufficient opportunity for interdisciplinary group action and individual action for both students and faculty.

BENEFITS -- The course will serve to provide the student with an understanding of the system and its: economics, data, processes and interfaces, goals and alternatives, components and arrangements, measures of effectiveness, methods of futures forecasting and analytical tools. From this training the student should derive a more comprehensive understanding of the operation of the Urban Environmental System.

Urban Environmental Systems

Intersession Course

Prof. George W. Reid, Director

May 12-23, 1975

	Monday	Tuesday	Wednesday	Thursday	Friday
9:00 am	12 Overview of course (G. W. Reid)	13 Physical Systems (G. W. Reid)	14 World Population Problems (Dr. James Bohland)	15 Urban Wastewater Problems (Bill Roach)	* 16 Environmental Law (Marian Opala)
10:00	Urban Scene (G. W. Reid)	National Transportation Systems (Antti Talvitie)	National Transportation Problems (Hugh Warren)	* Air Pollution (Dr. Bob Nelson)	General Modelling (Silas Law)
11:00	Human Systems (Gay Adams)	* Community Environmental Impacts (Laura Thomas)	* National Sedimentation & Drainage (Leonard Solomon)	* National Energy Problems (Martha Gilliland)	Community Development (Dr. Frank Hersman)

* taped sessions

Intersession Course Continued

	Monday	Tuesday	Wednesday	Thursday	Friday
9:00 am	19 National Data Information (Ralph Martin)	20 Technical Forecasting (Silas Law)	21 National Solid Waste Problems (Cal Grant)	22 Water & Sewage (G. W. Reid)	23 Political COG's (Jerry Lasker)
10:00	National Water Problems (Dr. Ralph Harkins)	Systems Approach (G. W. Reid)	International Environmental Health (Dr. Frank Goldsmith)	Airport Model (G. W. Reid)	Diffusion (G. W. Reid)
11:00	National Housing Finance (Dr. Bob Anderson)	Economic Models (G. W. Reid)	Models Air Pollution (Dr. Bob Nelson)	Manpower & Education (Gay Adams)	Summary (G. W. Reid)

COURSE INSTRUCTORS AND TITLES

Dr. Bob Nelson
Associate Professor,
School of CEES
University of Oklahoma
Norman, Oklahoma

Dr. Martha Gilliland, Professor
Science and Public Policy
University of Oklahoma
Norman, Oklahoma

Marian Opala, Director
Oklahoma States Courts
Oklahoma City, Oklahoma

Dr. Silas Law, Assistant Director
Bureau of Water and Env. Resources Research
University of Oklahoma
Norman, Oklahoma

Dr. Frank Hersman
Office of Inter-governmental Science Programs
National Science Foundation
Washington, D.C.

Ralph Martin
Director of Program Development, ORA
University of Oklahoma
Norman, Oklahoma

Dr. Ralph Harkins
Director of Monitoring
Kerr-Regional Environment Laboratory
USEPA
Ada, Oklahoma

Dr. George W. Reid, Regents Professor
Civil Engineering
Intern Advisor, Municipal Public Works Intern Program
University of Oklahoma
Norman, Oklahoma

Gay Adams
Research Associate
Intern Coordinator
University of Oklahoma
Norman, Oklahom

Dr. Antti Talvitie, Assoc. Professor
School of CEES
University of Oklahoma
Norman, Oklahoma

Laura Thomas
Community Development
USHUD Regional Office
Oklahoma City, Oklahoma

Dr. James Bohland
Associate Professor
Geography Department
University of Oklahoma
Norman, Oklahoma

Hugh Warren, Chairman
Oklahoma Turnpike Authority
Oklahoma City, Oklahoma

Leonard Solomon, Director
Oklahoma Conservation Commission
Oklahoma City, Oklahoma

Bill Roach, Project Director
Water Quality Service
Oklahoma State Health Department
Oklahoma City, Oklahoma

Dr. Bob Anderson
Director of Housing
Office of Community Affairs and Planning
Oklahoma City, Oklahoma

Calvin Grant
Acting Deputy Commissioner of Health
State Health Department
Oklahoma City, Oklahoma

Dr. Francis Goldsmith
Assist to the Deputy Administrator
Health Services Administration
Rockville, Maryland

Jerry Lasher
Director of the Indian Nations COG
Tulsa, Oklahoma

University of Oklahoma

Course Evaluation for "Urban Environmental Systems"

Name: ____ Date: ________________

Occupation/Position: ____

What is the reason for your interest in this course? ________________________

____

____

What was your previous degree of exposure to the presented material?

____ great deal ____ quite a bit ____ some ____ none at all

I. Course Organization

Please circle one response to the following questions:

A - always; B - often; C - sometimes; D - occasionally; E - never

1. Objectives were clearly stated and followed throughout the course.

   A B C D E

2. The course integrated the related material effectively.

   A B C D E

3. The course emphasized what you perceived as the most important aspects of the material.

   A B C D E

4. The topics of the course were timely.

   A B C D E

5. The topics were important to your job or position.

   A B C D E

6. Was the course well organized as to:

   (1) content: A B C D E;

   (2) fluidity of course sections: A B C D E

Please answer each question. If an elaboration or written answer is called for, please use the back of the page.

Description of Sections

Section 1 - Overview, urban systems and their problems, living patterns, planning.

Section 2 - Modeling, goals, alternatives and strategies, quality of the environment, population models, forecasint and the demand model.

Section 3 - Water supply, wastewater treatment and disposal.

Section 4 - Solid Wastes.

Section 5 - Air pollution prediction model.

Section 6 - Transportation, airport housing and drainage models.

		S 1	S 2	S 3	S 4	S 5	S 6
1. Indicate the ease or difficulty of understnading the material.	Easy						
	Moderately easy						
	Moderately hard						
	Difficult						
2. Indicate the importance of each section.	Important						
	Fairly important						
	Not so important						
	Unimportant						
3. Should this section be expanded or reduced in coverage?	Expanded						
	Left the same						
	Reduced						
4. Which were the 3 most practical or appropriate sections?	First						
	Second						
	Third						

5. Would you change these sections or their components, in content or emphasis, to make them more responsive to your needs? How?

Sec. 1 ______________________________

Sec. 2 ______________________________

____

____

Sec. 3 ______________________________

____

____

Sec. 4 ______________________________

____

____

Sec. 5 ______________________________

____

____

Sec. 6 ______________________________

____

____

II. Methods of Presentation

Please circle the method(s) of choice for presenting this material. List topics that could be more effectively taught with each method.

1. LMI - lecture method of instruction with opportunities for questions.

____

2. Panel or group discussions ______________________________

____

3. Assigned readings with a seminar format ______________________________

____

4. Compacted presentation, with the course compressed to 2 weeks or less. ______________________________

5. Case studies ______________________________

____

6. Utilize a multi-media learning center with individualized instruction. ______

7. Problem oriented learning situations ______

8. Uncertain ______

9. Other methods ______

III. Supplemental Teaching Aids

Circle those you would like to see used in presenting this material. List the corresponding topic(s) you feel could be most effectively illustrated by each aid.

1. Pictures, slides and other illustrative material ______

2. Study questions and topics handed out by the instructor ______

3. Films ______

4. Field trips ______

5. Lab demonstrations ______

6. Other ______

IV. Evaluation

Circle the method(s) of evaluation you recommend for this course.

1. Evaluation not needed

2. Pass/fail notation only

3. Term paper to be used as grade

4. Final or midterm and final

5. Tests over each section

6. Other ______

V. Please list any additional recommendations, comments or observations, pro or con, which you feel would help to improve this course in any way.

APPENDIX B

THE MOUNT CARMEL DECLARATION

ON

TECHNOLOGY AND MORAL RESPONSIBILITY

The Declaration was adopted at the conclusion of the Wunsch International Symposium on "Ethics in an Age of Pervasive Technology", held at Technion City, Haifa, and at the Residence of the President of the State of Israel, Jerusalem, December 22-25, 1974, to mark the fiftieth anniversary of the Technion-Israel Institute of Technology.

We, the undersigned, meeting at Haifa to celebrate the fiftieth anniversary of the Technion - Israel Institute of Technology, deeply troubled by the threats to the welfare and survival of the human species that are increasingly posed by improvident uses of applied science and technology, offer the following Declaration for consideration and adoption. It is addressed, most urgently, to all whom it concerns, to governments and other political agencies, to administrators and managers, experts and laymen, educators and students, to all who have the power to influence decisions or the right to be consulted about them.

(1) We recognize the great contributions of technology to the improvement of the human condition. Yet continued intensification and extension of technology has unprecedented potentialities for evil as well as good. Technological consequences are now so ramified and interconnected, so sweeping in unforeseen results, so grave in the magnitude of the irreversible changes they induce, as to constitute a threat to the very survival of the species.

(2) While actions at the level of community and state are urgently needed, legitimate local interests must not take precedence over the common interest of all human beings in justice, happiness and peace. Responsible control of technology by social systems and institutions is an urgent *global* concern, overriding all conflicts of interest and all divergencies in religion, race or political allegiance. Ultimately all must benefit from the promise of technology, or all must suffer - even perish - together.

(3) Technological applications and innovations result from human actions. As such, they demand political, social, economic, ecological and above all *moral* evaluation. No technology is morally "neutral".

(4) Human beings, both as individuals and as members or agents of social institutions, bear the sole responsibility for abuses of technology. Invocation of supposedly unflexible laws of technological inertia and technological transformation is an evasion of moral and political responsiblity.

(5) Creeds and moral philosophies that teach respect for human dignity can, in spite of all differences, unite in actions to cope with the problems posed by new technologies. It is an urgent task to work toward new codes for guidance in an age of pervasive technology.

(6) Every technological undertaking must respect basic human rights and cherish human dignity. We must not gamble with human survival. We must not degrade people into *things* used by machines: every technological innovation must be judged by its contributions to the development of genuinely free and creative *persons*.

(7) The "developed" and the "developing" nations have different priorities but an ultimate convergence of shared interests.

For the developed nations: rejection of expansion at all costs and the selfish satisfaction of every-multiplying desires - and adoption of policies of *principled restraint* - with unstinting assistance to the unfortunate and the under-privileged.

For the developing nations: complementary but appropriately modified policies of principled restraint, especially in population growth, and a determination to avoid repeating the excesses and follies of the more "developed" economies.

Absolute priority should be given to the relief of human misery, the eradication of hunger and disease, the abolition of social injustice and the achievement of lasting peace.

(8) These problems and their implications need to be discussed and investigated by all educational institutions and all media of communication. They call for intense and imaginative research enlisting the cooperation of humanists and social scientists, as well as natural scientists and technologists. Better technology is needed, but will not suffice to solve the problems caused by

intensive uses of technology. We need *guardian disciplines* to monitor and assess technological innovations, with especial attention to their moral implications.

(9) Implementation of these purposes will demand improved social institutions through the active participation of statesmen and their expert advisers, and the informed understanding and consent of those most directly affected - especially the young, who have the greatest stake in the future.

(10) This agenda calls for sustained work on three distinct but connected tasks: the development of "guardian disciplines" for watching, modifying, improving and restraining the human consequences of technology (a special but not exclusive responsibility of the scientists and technologists who orginiate technological innovations); the confluence of varying moral codes in common actions; and the creation of improved educational and social institutions.

Without minimizing the prevalence of human irrationality and the potency of envy and hate, we have sufficient faith in ourselves and our fellows to hope for a future in which all can have a chance to close the gap between aspiration and reality - a chance to become at last truly human.

No agenda is more urgent for human welfare and survival.

APPENDIX C

EDUCATIONAL METHODS

Background

This appendix presents descriptions and discussions of some relevant types of educational methods. Advantages and disadvantages of each are related to how they could fit into this program. The discussion, by necessity, is not all encompasing, but focuses on those alternatives in popular use. Even though studies have shown learning to be independant of methodology, the presentation method employed may greatly influence the setting in which learning occurs and therefore can have a strong effect on student motivation which does reflect on student learning. A major source for many of the methods discussed herein are from Teach-In:Suggestions for Developing College Instructions, Learning Resource Program, Utah State University, Logan, Utah, 1972.

Liberal Studies

Masters of Liberal Studies degree is a program offered through the Oklahoma Center for Continuing Education by the University of Oklahoma. It is a complete educational program suitable for those already working who desire to further or complete their formal education. The student is assigned a three member committee that directs the student in reading and investigative work that leads toward eventual completion of a master thesis.

The first phase of the program consists of off-campus directed readings. Each of the committee members assign readings to provide an in-depth look at some relevant portion of the member's specialized area.

After the student has acquired a body of knowledge to the extent which satifies both himself and the committee, the student attends a three week, on campus seminar, in a subject area tailored to be relevant to his body of knowledge, work experience, and professional objectives. The seminar is made up of students and faculty with broad backgrounds in these general areas. These seminars familiarize students with salient problem areas and present differing viewpoints and inter-actions from other students.

The seminars can utilize various teaching methods including team teaching and panel discussion. They can be developed to allow student interaction around a common theme pertinent to all students.

The MLS Program is highly adaptable without imposing confinements of time, space, and distance on the student. One is able to proceed at a pace geared to one's own learning speed and other commitments. Scheduling of seminars is variable and the students have a great amount of leeway as to when they may attend the seminar. Judging of comprehension, questions, etc. are accomplished through writings or personal discussions depending on where the student resides in relation to the university. A program based on the framework of University of Oklahoma's MLS program would be ideally suited to accomodate those persons seeking to further their education while concurently pursuing a profession or career. The student need not be present on campus for the majority of the learning experience. The program accomodates individually designed programs that draw on resource outside of those traditionally provided by the colleges.

There are, however, disadvantages--primarily the lack of direct continuous faculty-student interaction and lack of accessibility to university research facilities and materials. Generally, othe provisions can be arranged to largely negate these disadvantages.

Open University

The Open University is one system of disseminating information to the public-at-large through correspondance courses, use of libraries (public), T.V., or any other method of reaching interested students without maintaining a physical campus. The Open University is able to take advantage of established programs, materials, and course descriptions that have been developed by parent institutions or developing programs designed to suit specialized purposes. These programs are generally used as supplements to a rigorous, self-study correspondence course.

This approach is similar to the MLS educational philosophy in that neither system requires the student to be on-campus to participate and does not confine the student by rigid time schedules or prescribed course work. They both provide much needed flexibility in cutting across traditional departmental lines. Open University differs from MLS in that usually no formal entrance requirements are necessary, whereas, the MLS requires a baccalaureate degree for entrance. Open University is particularly appealing to those students unable to attend on-campus institutions and particularly for older students who may have dropped their studies earlier in life or who have a newly discovered interest. Supplemental programs of the Open University are generally broadcast on radio and television. Many institutions have found it beneficial to provide a learning center type of facility to be used for tutoring, special presentations, films, tapes, and student interaction.

Open University may also be used by regular universtiy students who wish to gain more subject background or who wish to proceed at a faster pace than regular intitutional learning. Fees and tuition are charged for Open University credits to try to regain some of the expenses incurred.

Open University is a most effective way of reaching a large number of students and offers these people the advantages of few restrictions and compliances a regular university student must operate under. Although it has been tried in science and engineering, as for its applicability to a master's level program in the environmental related sciences, it may have weak points. First, where the MLS program is geared toward persons having a direct bearing on real-world related decision-making, the Open University undertakes no specialized aim. Second, the M.S. in Environmental Science is usually problem-oriented with an emphasis on actual problem solving situations. This requires close supervision and direction, something Open University strives to avoid. Third, to support the generalized problem approach, the curriculum should be designed to provide the student with an understanding of familiarity of many phases of the environmantal problem. Unless course work has a basic rational structure, the fundamental goal of the M.S.E.S. program could be by-passed in the Open University framework. This is not to imply that the Open University cannot supply basic understanding of an environmental program or that the program can only be successfully administered on-campus. Rather, the framework of an individually tailored program such as the MLS would be a preferrable vehicle to an open and largely diverse curriculum administered through Open University, especially at the master's level.

On-Campus Programs

The on-campus program is the program of choice but certainly the most expensive by far. This program is more widely administered and used throughout the world than any other system. It would be preferred by most colleges and universities simply because the faculty, physical plant, research facilities, labs, etc. are already in existance and require no additional expenses of establishing alternative systems.

The on-campus program, or traditional method, is characterized by the student completing a structured amount of course work for credit which, after a specific number of credits are earned, leads to the awarding of a degree. Courses are generally established around a theme common to the administering college utilizing the lecture system and specific time frame.

The following section describes various on-campus programs.

1. Lecture Method of Instruction (LMI). The lecture system is the subject of continuing criticism because effectiveness depends too much on the ability of the lecturer to organize his materials properly, to present the material in an orderly and interesting manner, and to have an established goal in mind as to what the student should be able to accomplish from the information presented in the lecture. If a goal is to cover a large quantity of information or to explain and interpret texts, a lecture may be justifiable teaching mode. If the teacher is acting as an important authority, the patience and receptivity of his

class is easily jeopardized due to over-exposure.

During a lecture, most students feel they are required only to listen and take notes. If they have done any assigned readings in texts or outside materials, chances are good that the lecturer's address will be redundant. If the teacher's objective is anything besides note-taking, he must be able to project those objectives and involve the class through discussions, asking questions that require more than rote answers and other techniques that will involve the student in the learning process. Activities that require thought, analysis, and application should be included in every lecture lest students interpret the LMI as a listen and recall exercise.

Lectures have a valid place in the programs of every school, but the mistake of depending on lectures as the sole means of conveying information can easily lead to disinterested students who view the degree as just reward for enduring the drudgery of boredom and not for knowledge gained.

2. Intensive Courses. Concurrent course work is the traditional scheme of taking several courses simultaneously for a full term. Each course usually meets three times a week for one hour. By contrast, an intensive course is one that meets every day for several hours with a total elapsed time span of only a few weeks. (Also referred to as Blocking.) The intensive course yield the same credit hours as a concurrent course but has several advantages. First, an intensive course allows total concentration by the student on the course work. He is not distracted by competing demands from other courses. By freeing himself from the necessity of picking up and putting down, of constantly shifting mental

gears from one subject to another, the student is better able to concentrate fully on the subject at hand. Second, the teacher is allowed the freedom of dealing with one subject and one group of students at a time. By teaching courses in an intensive manner, faculty are more apt to be better prepared in their subject matter. Additionally, the amount of time spent together makes primary interaction between students and teachers almost impossible to avoid. The teacher expands from lecturing to receiving with his students. Intensive teaching allows for a much better grasp of the subject by students since time limits imposed by concurrent courses often tend to end discussion and presentation before a subject has been adequately covered.

An intensive program may be developed by simply modifying an existing course schedule. Changes can be made so that a three hour class is arranged to meet every day, or five hours per week. In this way, a course can be completed in two-thirds the regular time. This type of course blocking frees the professor to pursue travel, research, or community service projects. The students benefit by being free to undertake directed readings, independent study, or research projects in an area of particular interest.

Individualized Learning Systems

1. Programmed Learning. This is a method of presenting course material in printed capsules where the student must interact with the material he reads and give appropriate answers before proceeding to the next information capsule. It is a system of supervised self-instruction where the student explores modular capsules of information. It is adaptable to individualized learning packages assembled by the instructor.

Some programs are commercially available or can be tailored for each instructional area. Students are able to proceed with desired learning at their own pace. The programs can be constructed to teach precisely the concepts intended, yields immediate feedback to the student, and does not require the presence of an instructor.

At the masters level, the use of programmed learning would allow students to explore interests on their own initiative, investigate areas of special concern, and gain better comprehension of study areas. The Learning Center can be used to present a wide range of information at any time to any student.

2. Independent Study. (Sometime called a Store Front Classroom.) Independent study at the masters level has traditionally been associated with the conception, research, and production of a thesis. Independent study is a tool that can and should be used in a broader realm. Normally, the superior student is the one expected to pursue independent study, but it is a misconception that only superior students are capable of this type of achievement.

Independent study allows the student to venture beyond the point of being continually directed by faculty. In this case, faculty act more as advisors to help generate creativity and resourcefulness on the part of the student. Independent study is aimed at enabling the student to function as a teacher in his own right and be able to seek and find answers to his own inquiry. The student who participates in independent study will be able to reclaim some of the responsibility for his learning instead of leaving it totally to the institution to provide the setting for his curiosity.

The instructor plays an important supervisory role in independent study by (1) helping the student establish an area and topic in which he wishes to investigate, (2) establishes the depth and breadth of study, (3) provides the beginnings of the study, (4) indicates what results to strive for, and (5) evaluates student performance. The student is then left to initiate the topic, do research, collect and interpret data, develop conclusions, and present his findings in writing.

In an engineering school environment, independent study does have certain pitfalls which are reflections of the student's prior educational experiences. The usual engineering education is a highly structured course system that perhaps is not cognizant of the value of independent study. The traditional system generally assumes total responsibility for what the student learns and when he learns it. The student is fully aware of how to respond to this situation.

Since independent study thrusts responsibility back on the student, the freedom of this open-ended learning is likely to leave him somewhat bewildered. Thus if independent study is to be utilized as it should be and the student has no prior acquaintance with independent inquiry, the faculty must move with caution and lead the student along to the point where the student can handle it.

3. Discussion Group. The discussion group can play an important role in masters level education. Frequently, many students and faculty are engaged in related problem areas or are interested in common topics. This mutual interest can be put to good use in a discussion group.

Discussion groups are more effective when approached on a small scale. The discussion leader must be careful to refrain from dominating the group and controlling it from his point of view. This approach is likely to kill active interest and participation as free exchange of ideas and viewpoints are constrained. Discussion groups must be task-oriented with each participant aware of what is expected of him in the way of preparation and participation. Reward must be focused on the topic under discussion to facilitate active participation.

For large groups, the panel discussion may be appropriate. Students could act as observers of a discussion between well informed persons with the option of forming questions or asking for illumination from the panel members. The panel discussion would be especially useful where the topic is somewhat unfamiliar but related to student interest.

4. Seminar. The seminar is an excellent vehicle for persons knowledgeable in a particular subject to explore a particular question or case study in depth. The goal of a seminar should be to gather and dispense data to all participants for critical analysis. It is not the place for the moderator to expound theory nor is there time to hear people argue one point. The key to a successful seminar is to guide the learning process toward a point where an inquiring atmosphere prevails. To thwart this atmosphere or to prepare inadequately for the seminar is likely to ruin its effectiveness.

5. Simulation/Gaming. The simulation game is recognized as a bridging action between abstract learning and problems faced in reality. Simulation if a model of reality and as such, the many involved variables cause different responses. The game is constructed around the interaction of variables, using only 5 or 6 to keep the game on a simple level. The participant is forced into making rational decisions to manipulate the

the variables as he perceives the reality of the situation. His manipulation causes a reaction that must in turn be analyzed and reacted to. This type of game involves students in a close approximation of a real situation except time is greatly condensed. The simulation of applying knowledge to a real situation is a great stimulator in a learning situation.

To realize these advantages in learning, the instructor must understand its important points. He must be completely familiar with the interaction of the variables and be able to keep the game moving. Also, he must include an after-the-game debriefing to help the students understand generalizations and the principles that emerge.

Simulation gaming can be an important tool in addressing environmental concerns. Ready-made programs are currently available and experience should enable one to devise his own games. The practicality of relating games to a real situation would go far in reducing the shock of out-of-school transition.

6. Laboratory and Field Practice. Lab work and field practice are often separate from course work. Students are confused by lab activities because they sometimes do not fully coincide with classroom work. Students become concerned mainly with the results of experiments rather than the processes they are based on. Quite often the time for completion is too short to allow the student time to truly explore and reason-out what he has done. If new ideas are presented in the lab, they often become detached from other parts of the course in the minds of the students.

Lab and field practice should be an extension and exploration of ideas and concepts expressed in the classroom. The lab is designed to give students a grasp of the workings of science and the lab write-up should reflect a knowledge of the principles involved, not just explanations of processes and results.

The open lab is a relatively new approach to such work. The students are shown a demonstration of a lab technique, then asked for new approaches to the problem and new experimental methods or designs. This activity involves the student and forces him to conceptualize the problem at hand yielding possible new solutions and an increased awareness of the processes involved.

7. Personalized System of Instruction (PSI). An alternative approach to integration of lab and lecture is found in application of the PSI method. Instead of breaking up lecture from lab, or lecturing during lab periods, Keller's method of combining lecture with lab into individual learning situations is impressive. This approach entails the use of recordings, film strips, and slides to teach the student the lecture course and the lab at his own learning pace. All information is provided that would normally be given except the experimental work is fully integrated with lecture material. This frees the student from having to rethink and apply last week's lecture to this week's lab. Practice and theory proceed together. Tests are given over each section and must be completely mastered before proceeding.

A disadvantage with this method is a restraining lack of flexibility in revising the course but is countered by the student's complete freedom to pace himself. The faculty is in close contact with students and, by the frequency of section exams, can tell if a student is moving too slowly or need assistance in some areas. Student progress between sections is positive reinforcement for individual achievements.

8. Film. The use of film is a popular teaching tool, but many instructors fail to use film to its best advantage. Before screening a film, the instructor should determine if it is the best one available and be sure to preview it before showing. The instructor needs to inform the students of what it is that is important in the film that applies to class work. Stopping the film to make or reinforce a point is a good technique as is only showing relevant parts of a film if it does not deal in toto with the subject. Debriefing after the film is important along with opportunity for class discussion.

Films have several serious disadvantages: they are expensive to produce; a specific film meets only particular subject requirements; seldom can an existing film be specific enough on a desired subject to provide the necessary insight which relates directly to the matter under study; since films become obsolete very quickly, alteration of a film is not possible without introducing discontinuities and incurring large financial expenditures.

9. Educational Television. In recent years educational TV has received widespread acclaim as an outstanding method of distributing quality educational opportunities to very large audiences. At the present time, educational TV is transmitted on closed circuit systems, broadcast over an organized network such as the PBS, or local stations.

Programming can be accomplished in two ways: real-time and video-tape. Real time presentations where two way communications are possible, allow instantaneous verbal exchange between student and instructor. These presentations closely resemble formal classroom situations except that only the image and voice of the instructor is present and not his physical person.

Videotaping offers maximum flexibility. Through a series of taping and careful editing, a clear, precise, and logical lesson can be produced. Videotape yields its greatest flexibility relative to where, when, and to whom a program is broadcast. Tapes can be made available through libraries, centralized learning centers, and even in the home.

Although educational TV offers greater exposure on a much wider geographical and numerical scale than the traditional institution, the medium does have certain limitations. TV is impersonal and is frequently boring when there is no physical person available to derive human interactions from. TV does not replicate the motivational efforts of a good instructor as they are tailored to a particular situation. TV removes the immediacy of the teacher-student personalized interaction. Motivation becomes a problem when the flexibility of TV scheduling precludes the requirement for structured presentations.

Dubin and his associates at the University of Oregon, have shown that the method of instruction makes no significant difference in the grades received in a subject. However, re-analyzing data from 132 education research projects done since 1924, one exception to this rule was found: two way TV tested as significantly less effective than other media. (Hollomon)

In spite of these difficulties, it seems that videotape may well be the instructional media of the future. The variety, depth, and breadth of instruction available with this tool is tremendous. TV presentations allow short-circuiting of tedious prerequisites which inhibit current traditional systems. These tools are especially useful to students who have an inclination for independent inquiry and those who are unable or unwilling to conform to formalized academics. Videotape libraries can also mitigate a lack of resources which some institutions may have in the form of trained staff and specialized physical plant. TV techniques should not necessarily be extensively implemented without extreme caution as students of today may not have the motivation, maturity, or exposure to adjust to this method of acquiring an education.

10. Pluralistic Approach. Participation in team teaching is an excellent way of promoting understanding between separate units of academia. Most students are unaware of the complexities and interrelatedness of divergent factions when studying a problem with implications outside ones academic field. In environmental sciences, the student would do well to explore environmental problems from the viewpoint of the sociologist, economist, lawyer, and other professions. Students tend to view their approach to a problem as THE approach without considering the true interrelatedness of all problems. The need for broader avenues to problem-solving is greater now than ever before and many of our current environmental problems are directly attributable to problem-solving from a narrow perspective. The importance of this interrelated approach is unquestionable. Every possible effort should be made to integrate the student's knowledge and actions with the demands of competing needs in society and nature.

11. Co-Oping and/or On-The-Job Training. Training under the guidance of practicing professional is useful for acquainting students with real world situations. This type of program requires good school-community relations. People in the community must be willing to spend time and effort acquainting students with the nature of the work being done as

well as integrating the student into a role of a responsible participant rather than observer.

Some universities encourage internship and CO-OPing with industry on a full time basis for an entire semester although field training can range from full participation to part time observation. Whatever the time spent or the nature of the student role, this type of learning experience is a valuable tie between abstract learning and real world applicability. The opportunity to see types of problems encountered, prevalent attitudes, and approaches to problem-solving is excellent experience for all students.

12. Personalized Individualized Process (PIP). This is a teaching method outside of the traditional mold. The technique is to break down the course work into a number of individual units learned one at a time. The full course is set out on paper in advance. The program requires that clear objectives for the course be established and made known to students. Students are allowed to proceed at their own pace but mastery of each unit is required before proceeding to the next. Responsibility for learning is placed on the student. Lectures and demonstrations are used as tools for motivating students to seek out information and not for instruction as such. Graduate students may administer exams over units whenever a student feels ready for it. Tests can be repeated and scoring is immediate.

Results of PIP are that learning is positively reinforced and threatening or adverse learning situations are avoided. Student reaction is favorable where PIP has been used. It seems to be much preferred over large classes or televised instruction.

Teachers also find this method useful as they can ascertain the class standing of each student and provide individual instruction where necessary. Students respond to careful course planning and know exactly where they stand at all times. The cost of this type program is very low.

13. Audiotory-Tutorial Method. This is an extension of the PIP method but is designed more for a lab-oriented course. It makes use of a learning center or lab that remains open for use whenever a student desires. It is a supervised self-instruction lab with other students available to help out and for on-the-spot tutoring by classmates.

14. Inquiry Learning. This approach develops a set of objectives to be achieved in observable learning and links those objectives with departmental goals. It is a trial and error approach to learning and problem solving. The instructor acts as a guide and interpreter rather than teacher/lecturer. The student acquires the skills of factual knowledge and comprehension and is expected to use these skills to develop the abilities of problem recognition, analysis, synthesis, and solution.

The instructor sets objectives for his students that are problem-oriented. A method of evaluation is established with a minimum standard of achievement which must be met. The students then work on the problem and are encouraged to be creative in trying to solve it. The teacher is required to be available to steer students from dead ends and to suggest feasible alternatives. No one correct solution is established thereby leaving room for creativity and innovation. Work submitted for evaluation is judged according to standards. If it falls short, critique is supplied and the student tries again until all standards are met.

This approach is highly recommended as a self-motivating approach to learning. It goes beyond self-instruction in that the work to be performed and the objectives realized are those of the instructor. However, the student must dig on his own to satisfy course requirements. Rather than being spoon-fed information, the student learns to function as an entity with the reward of knowing that his own efforts prevailed.

15. Case Study. The use of case studies for graduate education is a well accepted teaching technique. Students study an actual situation and analyze the actions of those involved in the design solution. This tool is useful because it serves as a link between theory and reality and reveals how people react to the stresses of real problems.

The goals of case studies are first to learn how to analyze the problem, and secondly, to grasp the concepts used in the actual solution. It follows that criticism of the concepts and suggestions of alternative solutions would be brought out and discussed by the class.

16. Directed Readings. This concept is widely used in college education but usually more on the graduate level. Directed reading is a method for students to acquire knowledge under a seeking-out approach guided by a faculty member. The instructor assigns readings based on the student interest. The student relies on the background and knowledge of the teacher to guide him to appropriate book and publications. Later, the student and teach meet to discuss what the student has read and what he got out of it. The teacher is able to evaluate what the student has learned and suggest other readings to add depth or breadth.

The benefits that the student derives are many. The teacher is able to provide tutoring, direction, and feedback for the student. He ha first hand knowledge of the student's appreciation of the subject as he progresses through the literature and is able to modify the readings to suit student needs. Therefore, the student's time is spent on important readings and not in references searches and evaluations as to whether a reference is pertinent.

17. Continuing Education. Continuing education is normally associated with two groups of people: recent graduates who are striving toward more advanced degrees; and practicing engineers who return to the classroom to learn of new fields that influence their practice or to upgrade their technical knowledge. (A third group may consist of persons who merely wish to learn about a new field of interest. Technical course offerings do not usually attract this clientelle.)

The role of continuing education for the engineering graduate has long been accepted as necessary to insure up-to-date acquaintance with the outer reaches of practice. Staying abreast of scientific or technical break-throughs and realizing their application is the only way to keep fresh insight and innovation a part of an engineer's practice. Some states are beginning to require of their registered professional engineers, 40 clock hours a year or more of accredited continuing education classes. In the Civil Engineer, ASCE, January, 1975 issue, it is projected that by the year 1985, most states will include continuing education on some level for PE's to maintain their good standing in those states. The requirements are similar to those imposed by the American Academy of General Practice for physicians. To maintain active membership, they must complete 150 hours of approved post graduate education in a three year period. The professional engineer faces similar requirements.

APPENDIX D

NATIONAL ENVIRONMENTAL POLICY AND LEGISLATION

The magnitude of environmental problems are such that independent or piecemeal methods of solution would be a futile effort and result in chaos. A national planned, coordinated, and well directed program is needed to provide the required leadership and guidance so essential for timely results. National attitudes underlie policy construction which in turn set the foundations for national committment. The national environmental attitude has not been lacking and the resulting voluminous outpourings from administrative agencies has been almost overhwelming.

The historical development of environmental law (Reitze:2) parallels the changing philosophical view of nature. Prior to the beginning of the twentieth century, the legal system was used to encourage the development and exploitation of our natural environment. The government encouraged canal building, and gave away millions of acres of public land to those who would exploit them. Beginning in the late nineteenth century, the concept of conservation became popular, and this resulted in legislation to conserve at least some of our natural resources. John Muir became the nonexploitation conservationist while Giffort Pinchott was the leader of the careful extraction school of conservation.

A subsequent realization was the recognition of the need to humanize technology to serve human needs as proposed by Admiral Rickover. Murray Bookchim calls on man to master his technology in order to live, but says this requires a social reconstruction (for another view on this, see Shane:59

and Chapter IV). Charles Reich in The Greening of America recognizes the social relationship necessary to end environmental and social abuses.

The philosophy of natural recources management is rarely labled as such, but the aims, attitudes, and goals of government are the embodiment of the philosophy of the nation. The kind of planning engaged in by a nation is determined by its view of the ethical relation of people to the environment. The absence of a strong recognition of the values offered by a natural environment make legal protection difficult.

Government touches environmental concerns in many ways, through the role of taxes, various abatement incentives for industry such as state and local tax credits, etc. New fees and taxes are being proposed such as an effluent fee system and taxes on emission pollution inventory elements like lead and sulfur.

There are at least five congressional standing committees in each of the House and Senate which usually have jurisdiction on environmental bills. A listing of the committees and subcommittees and their areas of concern can be found in appropriate publications such as the Conservation Directory from the National Wildlife Federation and others.

The federal budget for the environment is contained in the section called "Natural Resources and the Environment" and reveals a complexity requiring concentrated study and dedication to really determine the programs of environmental concern. However, the great publicity given environmental problems has not produced substantial change in budgeting. (Reitze:63) Those who agree with present budgeting often defend spending priorities by comparing total government spending (federal, state, and local). All sanitation programs, health programs, hospital support, and natural resource programs at all levels of government combined account for less than ten percent of the government's spending. Like all numbers games, natural resource expenditures can be misleading for about two thirds of the natural resource budget is for water resource and power development projects. A high percentage are environmentally destructive, and many of the most publicized conservation battles have involved attempts by citizens to prevent ecological destruction financed by the federal treasury (Reitze:63).

A budgeting summation follows (Reitze:77) :

> "What this really shows is that the determination of what is a pollution controlling activity is not simple. The locating of housing and stores to encourage people to walk rather than to ride their cars would be an example of a real pollution-controlling activity, yet would not likely be listed under Pollution Control and Abatement. In short, pollution control is dependent on life style, and many decisions besides those to build a sewage treatment plant or purchase smokeless propellants affect such control. The Federal Budget reflects literally hundreds of thousands of such life-style decisions."

Federal Government agencies dealing with the environment include: the Environmental Protection Agency (the key federal effort to protect the environment); the Council on Environmental Quality; the National Oceanic and Atmospheric Administration; the Department of the Interior: the Army Corps of Engineers; the Department of Agriculture; etc. The agencies and bureaus perform various functions including: standards-setting and enforcement; research and monitoring; technical and financial assistance; manpower development; and others.

A complete governmental organizational outline along with functional descriptions is not within the scope of this study. The point to be made is that the various levels of government are devoting a significant amount of time, effort, and money on the many facets of environmental problems. These are the sources of the incentives which support and promote the solutions to envrionmental problems.

The United States government is formally committed to encouraging "productive and enjoyable harmony between man and his environment". This promise is made in the National Environmental Policy Act of 1969 which was the culmination of a decade of previously unsuccessful congressional attempts to define and put into practice a national environmental policy. Subsequent legislation included:

The Environmental Quality Improvement Act of 1970;
Executive Order 11514, Protection and Enhancement of
  Environmental Quality, March 5, 1970;
The Solid Waste Disposal Act;
The National Materials Policy Act of 1970;
Air Quality Act of 1967;
Clean Air Act of 1970;
Federal Water Pollution Control Act; and etc.

Some of the states have taken multi-lateral legislative action and adopted their own environmental protection acts as public policy. Some states have adopted a constitutional right to a healthful environment by each person.

APPENDIX E

DEFINITIONS

1. Environmental terms used throughout the report are in accordance with those listed in:

> Studdard, Gloria J., "Common Environmental Terms; A Glossary", U.S. Environmental Protection Agency, 1974.

2. The Environmental Education Act of 1970 (P.L. 91-516) defines environmental education as "the educational process dealing with man's relationship with his natural and manmade surroundings, and includes the relation of population, pollution, resource allocation and depletion, conservation, transportation, technology, and urban and rural planning to the total human environment.".

3. P.W. Purdom, General Chairman of the Third National Environmental Engineering Education Conference, Drexel University, 1973, defines "Environmental engineering is that branch of engineering which is concerned with (1) the protection of human populations from the effects of adverse environmental factors (2) the protection of environment both local and global from the potentially deleterious effects of human activities and (3) the improvement of environmental quality for man's health and well being.". (Purdom: 13)