UNDERGRADUATE CIVIL AND ENVIRONMENTAL ENGINEERING AND TRANSPORTATION ENGINEERING NEEDS

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Civil engineering in general and transportation engineering are rapidly changing fields in which engineered facilities intimately interact with society and the environment. However, proper interaction can only be ensured if the involved professionals are aware socially and environmentally and are adequately trained technically. The new curriculum in civil and environmental engineering at the University of Wisconsin, while it recognizes that education is a continuing and life-long process, has as its main purpose the training of engineers who not only are technically competent but also have sufficient breadth to be able to appreciate and relate to society and the environment. The curriculum provides ample opportunity for significant study related to analysis, design, synthesis, and general engineering. Opportunities for multidisciplinary involvement are also available and encouraged. The new curriculum provides the opportunity, it is felt, for a firm foundation in technology plus the capability to weave that technology into the fabric of society.

•IT HAS BEEN SAID that "A student who can weave his technology into the fabric of society can claim to have a liberal education; a student who cannot . . . cannot claim to be a good technologist." Increasingly, civil engineers, and among them transportation engineers, are becoming more sensitive to the nonperformance consequences of their actions. For many years the profession has been concerned with the performance function only. In transportation, the major concern was the dollar costs and benefits of transportation facilities and measures of performance efficiency with little regard, except superficially, for the nonperformance social and environmental costs and benefits associated with their actions.

The emerging social and environmental concerns of engineers result partly from a new and greater understanding of man's needs and wants and of how man relates to other men and to his environment. This emerging concern has, in part at least, paralleled the rising national awareness of man's impact on the environment and the need to protect that environment. But it has also been the natural result of increased adverse public reaction to various engineering proposals. The transportation engineer, for example, is all too familiar with the crescendo of opposition to major highway improvements, particularly in urban areas. Whereas it has put him on the defensive, it has also increased his level of environmental awareness and caused him to take a new look at his engineering value system.

CREATING AWARENESS—THE START

Logically, creating greater environmental awareness and responsiveness in the engineering profession should begin with the engineering education process. This fundamental fact is recognized in the new curriculum in civil and environmental engineering at the University of Wisconsin. The basic philosophy underlying development of the new curriculum is the requirement that it embrace the concept of a broad education and at the

same time permit the kind of flexibility that would allow major course groupings leading to specialization. Within this context, sufficient attention is paid to applying theory to physical phenomena, to providing significant design course work that will emphasize the application of basic principles, and to providing group problem-solving experience directed at resolving real-life problems.

CURRICULUM OUTLINE

The basic curriculum consists of 135 credit hours. Flexibility is provided without sacrificing basic science and other fundamentals by permitting a wide array of elective courses. Within each of the areas from which electives are chosen, broad guidelines ensure breadth without sacrificing the desired flexibility.

The elective credits devoted to technical subjects relate to analysis, design, synthesis, and general engineering practice and give the student an opportunity to

1. Continue to develop in the broad field of civil engineering by dividing his electives fairly equally among the five divisions of instruction (structures, hydraulics, sanitary, transportation and city planning, and surveying/photogrammetry/remote sensing),
2. Specialize in one or more areas of activity in civil engineering,
3. Participate in interdisciplinary programs, and
4. Participate in depth in elective programs in other departments of the engineering college.

The technical electives, of which 6 must be in civil and environmental engineering, permit additional technical depth and enrichment in professional and scientific training. The remainder of the technical electives can be satisfied by numerous courses of a technical nature within or outside of the College of Engineering.

TRANSPORTATION OPTION

A major advantage of the new curriculum is that it permits specialization at the undergraduate level. In transportation, several tracks are available depending on student interest.

CURRICULUM DEFICIENCIES

The potential shortcoming of the new curriculum is the omission, at a very early stage, of an environmental core consisting of courses in basic ecology, natural resources and their utilization, and technology-society-environment interrelationships. Although such a core can be developed through selection of courses in natural sciences and liberal studies, such a core might appropriately be a required part of any civil and environmental engineering curriculum.

Other areas that should be covered specifically within the curriculum because they impinge so directly on all of the activities in civil and environmental engineering include decision-making, both public and private, community/citizen goals and values, and community/citizen participation.

CURRICULUM TRANSITION

The problem of implementing a new curriculum and making a transition from the old to the new raises all kinds of new questions. A major one was to whom it applies. Junior and senior students are given a choice and can opt for either the old or the new curriculum. In so doing, so-called equivalent courses—those courses, both new and old, that satisfy the new curriculum—had to be identified. In some cases, course credit requirements were changed, old courses were dropped, and new courses were developed. Freshmen and sophomore students are required to pursue the new curriculum.

The high degree of flexibility permitted by the new curriculum and the opportunity for many choices require a very close and continuing relationship between the student and his adviser. Although all of the advising issues have not been answered, a logical approach appears to be one in which a student can select an adviser in his area of in-

terest. Unlike the present practice where the adviser changes yearly with the student's class standing, a student would keep an adviser throughout his course of study unless, at his request or through a change of curriculum direction, it became desirable to change advisers. Under development at this time is a new advising form that will show the up-to-date status of the student as it relates to the overall curriculum and the manner in which he is fulfilling the various curriculum requirements.

PROBLEMS ASSOCIATED WITH CURRICULUM REVISION

Undertaking the modification of an existing curriculum consumes an enormous amount of time and personal energy. It required the unselfish efforts of a six-man committee (one representative from each area in the Department of Civil and Environmental Engineering and a chairman without vote) for a period of 3 years.

An initial step (after the goals were identified) required an in-depth evaluation of the topic content of existing courses to identify precise needs, areas of duplication between courses (some overlap and duplication is necessary in the learning process), and areas of deficiency. In identifying new course needs (or major changes to existing courses), detailed course outlines had to be developed in parallel with the new curriculum.

One of the more difficult issues was related to tradition: Were there certain things that a civil engineer should know and be able to do, and what did this mean in terms of a minimum educational experience? The subject became a burning one when it involved the question of the required summer survey camp and a fairly heavy load in structural engineering. The camp was discontinued and the structural requirement reduced by one-half, but not without much soul searching and gnashing of teeth.

The major goal of affording students an opportunity to specialize raised another serious concern. To what extent would graduate programs be diluted, inasmuch as undergraduate students could take courses that they would normally have taken at the graduate level? Offsetting this was the realization that graduate work in a given field could now permit greater breadth in fields related to the area of specialization.

Some of the other issues related to (a) the accreditation requirements, (b) whether a curriculum should prepare students for the professional registration exams, (c) implementation, and (d) problems of interrelationships with other university departments. Among the latter were things such as course cross listings, course overlap, and tailoring courses, now taught by external departments, to the unique needs of the civil and environmental engineering curriculum, e.g., whether such courses as calculus and statistics would be more relevant if taught in the department and whether university policy would allow this change.

RELATION TO OTHER UNDERGRADUATE PROGRAMS

Although most programs involving formal multidisciplinary study are at the graduate level, undergraduates are able to participate in several combined (joint) programs.

Transportation and Business

A bachelor of business administration degree may be earned in addition to the bachelor of science in engineering by proper selection of electives throughout the program. It is necessary, however, to extend the total program by two or three semesters to permit the minimum 32 credit hours in business courses.

Transportation and Law

Superior students in engineering may be permitted to register in the law school during their senior year to begin work toward a law degree.

Transportation and City Planning

Within the Department of Civil and Environmental Engineering, BS degrees can be obtained in both city planning and civil engineering (emphasis in transportation) by selection of certain additional designated courses for a total requirement of 176 credits.

Environmental Studies Minor Option

By proper selection of a 9- to 12-credit core of courses outside of the College of Engineering in the areas of basic ecology, natural resources and their utilization, and technology-society-environment interrelationships, the transportation engineer can earn a bachelor of science degree in civil and environmental engineering with an environmental minor studies option. This program option, with the environmental designation entered onto the student's transcript (it is not a degree designation) was developed to provide an opportunity for engineers to obtain greater depth in environmental areas. In other fields of engineering, the program must include, in addition, environmentally related course work that is already a part of civil engineering and transportation engineering curricula. These include 3 to 6 credit hours drawn from an approved list of courses that devote a major share of their time to the solution of environmental problems (most courses in civil transportation engineering are already on this list) and a 3- to 6-credit practicum or similar course that uses a multidisciplinary approach in which students attempt to solve a real-world problem.

Undergraduates in civil and environmental engineering as well as in other engineering areas can also obtain, through proper use of their electives, a well-rounded background in areas other than engineering, e.g., geography and political science. The reverse is also true. Numerous courses in engineering are available for degree credit to nonengineering students.

RELATION TO GRADUATE PROGRAM

Increased understanding of how technology affects the man-environment system has resulted in a proposal for the development of a series of graduate-level environmental management programs, including one in transportation. Because of the interdisciplinary nature of the program, it would be under the umbrella of the University of Wisconsin Institute for Environmental Studies (IES). The institute has a unique structure in that it can provide effective leadership, coordination, and support for carefully integrated efforts involving various units of the university. The raison d'être of the institute is to develop and encourage interdisciplinary work on the multitude of environmental problems that do not lie within the purview of a single discipline.

The transportation management program has as its goal the preparation of graduate students for work in agencies responsible for managing and planning transportation systems.

Entry to the IES Transportation Management Program will be from engineering and the natural and social sciences. Although predominantly a graduate program, a number of the courses in the program will be offered at the intermediate level and, as a result, will be available for both undergraduate and graduate students.

The staff will be from the Institute for Environmental Studies (IES has departmental status) and from graduate programs in other departments.

Programs of study in professional management or research lead to degrees administered by a committee drawing membership from IES and other departments. For the transportation management option, the committee would be composed of IES staff, staff from the transportation/city planning area in civil and environmental engineering, and possibly staff from other areas.

CURRICULA IN OTHER INSTITUTIONS

A number of other institutions, among them Purdue, the University of Illinois, the University of California, Berkeley, and Massachusetts Institute of Technology, have developed engineering curricula that permit considerable flexibility beyond a required core of fundamentals. Each takes a slightly different approach.

SUMMARY

Civil engineering and transportation engineering curricula must be designed to train graduates who have both technical competence and an awareness of how their actions affect society and the environment. This level of training requires a strong foundation

in basic science and engineering and provides an opportunity to obtain a broad understanding of how man, society, and the environment function and an opportunity to gain considerable depth in a chosen field of specialization. These are not dichotomies; they can be effectively woven into a curriculum that is flexible and has depth and is interesting to students.

Because society and the environment, and how man views both of them, are changing rapidly, and because man's technology is also changing rapidly, the curriculum must be a dynamic one: continually changing and adapting to new needs and challenges.