TRANSPORTATION CENTERS AND OTHER MECHANISMS TO ENCOURAGE INTERDISCIPLINARY RESEARCH AND TRAINING EFFORTS IN TRANSPORTATION

Frederick J. Wegmann and Edward A. Beimborn, Systems-Design Department, University of Wisconsin—Milwaukee

The paper indicates directions and presents alternatives that may be considered in development of a transportation education program. The concept of interdisciplinary education is discussed by considering mechanisms used to establish such programs. Emphasis is given to the concept of a transportation center, and results of a survey of 17 schools with centers for interdisciplinary activities are presented. The function, administrative structure, academic involvement, and effectiveness of the centers are discussed, and comparisons are made in three fields of study: general transportation, urban transportation, and highways. Respondents' reactions to the centers in terms of meeting their objectives are presented and are intended as a guide to the future establishment of such centers. The strongest needs were expressed for continuity of funding and for the reliance on more than one sponsor. The need for administrative support and faculty interest was noted. It is pointed out that there should be a clear need for a center, which would heighten its chances of success. The types and levels of curricula are discussed, and two basic approaches (the menu and cafeteria types) are described. Other techniques in developing an interdisciplinary approach to transportation problems are seminars, team teaching, class projects, sharing of physical facilities, and use of operational gaming.

•THE past 5 years have witnessed profound changes in the basic manner in which transportation services are viewed, developed, and operated. The passage of the Federal-Aid Highway Act of 1968, the National Environmental Policy Act of 1969, and the Federal-Aid Highway Act of 1970, the expansion of programs in urban mass transit, and a rising level of concern on the part of the public over the shape of the transportation systems have all led to a new set of rules and directions for those actively engaged in the provision of transportation services. These changes have led to protection of parklands, TOPICS studies, environmental impact statements, noise and air pollution studies, relocation assistance programs, captial grants for mass transit, citizen participation panels, joint use projects, demonstration projects for innovative transportation systems, and so on. In all, this list represents extensive alterations to fundamental transportation policies and procedural considerations.

It is not surprising that these changes are having substantial impacts on transportation education programs at many universities. Immediately they have had the effect of creating a need to incorporate a broader array of subjects into the curriculum. Yet, a need still exists to anticipate what further changes may be forthcoming in the next 5 to 10 years so that the students leaving the program will be able to cope with future variations in policies.

Educational programs then must be responsive to current issues as well as to those of the future. Likewise educational programs must be responsive to those elements that have not been altered: the need to provide sound and economical designs, professional standards and competence, concern for safety, and a thorough knowledge of fun-

damentals. It is important that these qualities not be underemphasized or ignored in the rush to deal with those items that are of immediate concern.

A number of schools of higher learning have responded to the needs of contemporary transportation students by implementing educational programs of an interdisciplinary nature and away from more traditional single-discipline orientation (1, 2). The purpose of this paper is to discuss the concept of interdisciplinary education in transportation and to discuss mechanisms that are being used to establish such programs. Because of its prominence at many institutions, primary emphasis will be given to the concept of a transportation center as a mechanism to enhance research and training opportunities in transportation. The discussion will be based primarily on experience gained at the University of Wisconsin—Milwaukee (UWM) in applying such techniques. The overall thrust of this paper is not to advocate any one way of doing things but to indicate directions and alternatives that some schools are considering in developing an educational program oriented to the needs of both current and future transportation activities. It is hoped that the information presented here will be of use to others who are engaged in the development of transportation programs or to those who are faced with the task of hiring the students emerging from them.

THE INTERDISCIPLINARY APPROACH

Responsibility for providing basic transportation services today is a most complex task. It is evident from recent experience that no one profession by itself is able to contend with the many ramifications resulting from decisions to alter the quality or quantity of transportation services. In selected situations such as freeway location studies, this has given rise to joint concept teams where representatives from diverse disciplines such as architecture, engineering, economics, political science, and sociology all apply their knowledge and unique viewpoints to a complex transportation issue. In turn, greater attention has been given to the systems approach as a mechanism to make public-service decisions, e.g., provision of transportation services. Although the systems approach can be described as a sequence of steps such as defining objectives, developing alternative systems to meet the objectives, and evaluating and interpreting the alternatives in terms of their effectiveness, risks, and costs, its central contribution has been to ensure that transportation decisions reflect a large number of interrelated factors and systems. For example, highway planners must demonstrate that proposed highway improvements will be in accordance with local land use and development plans, have limited adverse environmental consequences, avoid displacement of persons without the availability of suitable relocation housing, and are coordinated with other modes of transportation.

In engineering as in other disciplines, this broader viewpoint requires a greater understanding of the social and environmental sciences, economics, political science, sociology, and ecology as well as natural sciences and mathematics. Such an understanding demands a broad background, one closely approximating the traditional concepts of liberal arts. However, engineering education still needs to be coupled with an understanding of technology and to provide the skills required to develop and intelligently use technology. With such a background, engineers in particular would be better equipped to modify and develop technology and its institutions to make them more compatible with and responsive to the changing values of our society.

The new viewpoint requires a shifting in educational programs. For example the graduating engineer interested in a career in the transportation industry (planning, design, operation, construction, or administration of transportation facilities) not only must be well grounded in the fundamentals of detailed design procedures but also must be given experience in general problem solving and analysis skills. As shown in Figure 1, the level at which the engineer desires to specialize will in part determine the breadth of his training. Advanced graduate programs in subjects such as soil mechanics, foundation engineering, or pavement design will not develop the same interdisciplinary mix as programs in transportation planning. For example the previous group will place greater reliance on applying the principles of the natural sciences such as physics and chemistry than on the social sciences. However, it is important that a soils engineer

have some appreciation of the transportation planning process and vice versa. Only through broader appreciation of the total picture with acknowledgment given to the role played by other disciplines can individuals learn to work and communicate effectively as members of multidisciplinary teams. It is essential that academic institutions provide the environment to allow individuals to establish lines of communication with and foster mutual respect for other disciplines.

The key question then becomes how to allow an engineering student or a student from some other discipline interested in transportation as a profession to acquire interdisciplinary experiences. It is evident that an interdisciplinary effort at a university does not occur naturally. Universities are generally organized along strict disciplinary lines, and it is often quite difficult to work across these boundaries. Furthermore, the reward system in a university often discourages interdisciplinary activities. Strong administrative support coupled with deliberate actions is required to bring about a working interdisciplinary research or training program. Yet the mere establishment of seminars or organizations such as a transportation center will not ensure an interdisciplinary effort. An interdisciplinary effort must exist as a real interplay of disciplines rather than on paper. Such an effort can exist without a formal structure. However, any formal steps taken on behalf of establishing an interdisciplinary approach should meet with greater success, assuming all other factors are equal, than relying totally on natural forces without prompting.

The remainder of the paper discusses various methods that might be used to establish an interdisciplinary approach aimed at fostering research and academic training in the area of transportation. One prominent avenue used by many institutions is the establishment of a transportation center, where the center forms the structure that allows various disciplines to join and bring their respective expertise to bear on complex transportation issues. Of course not all educational institutions have the ability to establish formal centers, and likewise the mere establishment of a center does not ensure development of an interdisciplinary effort. Other approaches and concepts can be utilized such as curriculum changes and seminars. Again it must be emphasized that these approaches are not mutually exclusive; rather, they are complementary.

TRANSPORTATION CENTERS

The concept of a transportation center has achieved prominence as a mechanism to foster research and academic training in the area of transportation (3). Although it is difficult to document the precise number of active centers, a 1969 survey completed by the Transportation Center Library, Northwestern University (4), provides one of the most complete inventories of university and college programs in transportation and traffic on a nationwide basis. For purposes of comparison, the programs were subdivided into the following four fields of study and research:

1. Transportation economics,
2. Civil engineering,
3. Urban transportation, and
4. Highway safety.

As given in Table 1, almost 70 percent of the identified programs in transportation and traffic have access to a center or institute concerned with transportation. Although this does not imply that all centers are effective organs for conducting research and training, and in fact it is highly questionable whether a number of the centers listed still function, just the sheer number of centers in existence at various universities and colleges interested in transportation is impressive. Also documented by the Northwestern University report is the fact that 15 of the 20 schools issuing more than 10 doctoral degrees in transportation (based on study in the fields of economics, geography, business administration, public administration, civil engineering, and history) between 1961 and 1969 had access to a center concerned with transportation. Again this is not a complete list, nor can it be assumed that the dissertation research was necessarily conducted through the auspices of the centers or institutes.

To better ascertain the role of a transportation center and to judge the experience gained by those institutions involved with centers or institutes concerned with trans-

Figure 1. Conceptual outline of interdisciplinary training for engineering students in transportation.

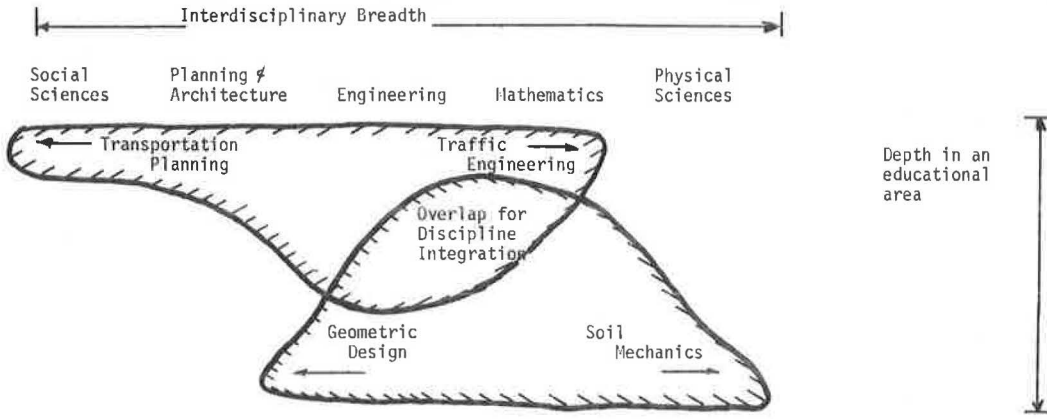

Table 1. Results of Northwestern University survey (4).

Subject Area	No. of Programs	No. of Centers	Percentage of Programs With Center Available
Transportation economics	35	21	60
Civil engineering	27	19	70
Urban transportation	29	19	66
Highway safety	15	13	87
Total	106	72	

Table 2. Distribution of centers responding to questionnaire.

Year of Origin	Type of Center			
	General Transportation	Urban Transportation	Highway	Total
Pre-1961	1	—	2	3
1961-1965	2	—	1	3
1966	—	—	—	—
1967	1	—	—	1
1968	—	3	—	3
1969	1	2	—	3
1970	2	1	—	3
1971	—	1	—	1

portation, we distributed a questionnaire to 30 schools that listed the availability of a transportation and traffic center. From these 30 schools, 20 replies were received, of which 17 were directly applicable to the questions posed. Although the survey did not include all transportation centers of national prominence, it is felt that the survey sample adequately reflected cross sections of currently operating centers.

For purposes of tallying the responses, the centers were stratified into three distinct groups. This was done with the intent of sharpening the responses. The distinctions were based on the premise that transportation centers or institutes generally have the broadest responsibilities including transportation and traffic, rural and urban problems, and a number of different modes. Urban transportation centers or institutes specifically focus on issues confronting urban areas, whereas highway programs primarily focus on the highway mode of travel.

Functions of a Center

The functions to be performed by a transportation center were most commonly characterized by combinations of the following:

1. Foster and/or initiate research in transportation,
2. Promote and/or enrich educational training programs in transportation,
3. Encourage interdisciplinary efforts,
4. Provide for the dissemination of knowledge, and
5. Provide community services and interaction between the community and the university.

Commonly a transportation center would have two or three of these functions as its mission. Most frequent reference was made to fostering research, promoting educational training programs, and providing for the dissemination of knowledge. Emphasis on the interdisciplinary effort indicated how these functions were to be accomplished and was common to many of the replies.

Specific responsibilities of a transportation center generally include

1. Identification of potential research sponsors,
2. Provision of research support through secretarial and library facilities,
3. Coordination of research between sponsor and researcher,
4. Serving as a research clearinghouse, and
5. Publication and distribution of research results.

Only 65 percent of the centers had responsibility for overseeing an academic program. Interestingly, all the urban transportation centers included in the survey identified overseeing of an academic program as a function, whereas only four of the 10 remaining centers identified this as a responsibility. The high degree of involvement in overseeing academic programs by urban transportation centers may be attributed to their involvement in research and training programs in urban mass transportation under financial assistance from the Urban Mass Transportation Administration (UMTA) of the Department of Transportation.

Age and Size of Center

Data given in Table 2 point out the recent proliferation of centers. For example, eight of the 17 centers included in this survey originated since 1968. Also it is interesting that all of the centers or institutes concerned exclusively with urban transportation were initiated after 1968. All but one of these urban centers are currently receiving financial support from UMTA Research and Training Grants that were initiated in 1968. The impact of government programs on the establishment of centers is again quite evident. The recent emphasis on establishing transportation centers is undoubtedly related to the changing mix of concerns confronting the transportation profession. To ascertain the size of operation of existing centers, we requested information on dollar size of current research involvement, number of research projects, and number of faculty and staff associated with the center. With this information we hoped to define the minimum level of research effort required to sustain a transportation center.

Table 3. Annual budgets of centers responding to questionnaire.

Annual Budget (thousand dollars)	Type of Center			
	General Transportation	Urban Transportation	Highway	Total
0-49.9	—	1	—	1
50.0-99.9	1	2	—	3
100.0-149.9	1	2	—	3
150.0-199.9	2	—	2	4
200.0-299.9	1	—	—	1
300.0-499.9	1	1	—	2
>500.0	1	—	1	2

Note: Average annual budgets are general transportation center, $280,000; urban transportation center, $115,000; and highway center, $345,000.

Table 4. Academic disciplines represented at centers responding to questionnaire.

Disciplines	Type of Center			
	General Transportation	Urban Transportation	Highway	Total
Urban planning	3	3	1	7
Economics	4	4	1	9
Civil engineering	5	4	3	12
Industrial engineering	1	1	1	3
Mechanical/aerospace engineering	2	1	3	6
Electrical engineering		1		1
Engineering-general	3	1		4
Geography	4	2		6
Law	2	1	1	4
Sociology	1	3	1	5
Political science	2	4	1	7
Business	4	1		5
Computer science	1	1		2
Real estate		1		1
Social research		1		1
Psychology	2	2	2	6
Chemistry, biology			1	1
Medicine			1	1
Physical education			1	1
Agriculture			2	2
Architecture	1			1
Mathematics/statistics	3			3
Regional science	1			1
As required	1	1		2

Table 5. Number of disciplines represented at centers responding to questionnaire.

No. of Disciplines	Type of Center			
	General Transportation	Urban Transportation	Highway	Total
0-2	1	1	0	2
3-4	1	1	0	2
5-6	0	1	2	3
7-8	2	2	0	4
9-10	1	0	0	1
>10	0	0	1	1
As required	1	1	0	2

The range in annual budgets varied from zero (one of the centers reported it was between research projects) to in excess of $1 million (Table 3). Most centers had an annual research budget of at least $50,000 per year. Generally, the older and more established the center was, the larger its budget was. The total budget represented by all the centers responding to the questionnaire was $3,685,000, with an average of $265,000 per center.

The source of funding most frequently indicated was the federal government. Specifically, only two institutions out of 12 did not rely on any federal funding to support the core staff (director and associate director), and only three institutions out of 14 did not rely on any federal funding to support the research staff. In fact, three institutions relied totally on federal grants to support the core staff, and four relied totally on federal grants to support the research staff. The number of institutions relying on individual, state, or university funding was small and generally limited to the lower percentages of support.

The number of projects undertaken varied at any given time depending on current contract obligations. Most commonly, centers undertook between one and five different projects and had a staff involvement of between two and 10 members at any one time. Not considering the center currently between projects, the number of projects varied from one to 40, with a faculty association of between one and 72 members.

Data given in Table 4 evince a broad range of disciplines represented in the centers. Just about all the centers had some degree of involvement with engineering. Within engineering, civil engineering was included at 12 centers, and mechanical and industrial engineering follow with four and three respectively. In four instances, engineering—general was listed. Other disciplines ranking high after civil engineering (12) were economics (9), urban planning (7), political science (7), mechanical/aerospace engineering (6), psychology (6), and business (5). Besides the specific disciplines involved with a center concerned with transportation and traffic, the total number of disciplines involved is of great interest. To a certain extent the number of disciplines represents the concept of "critical mass." Two institutions indicated that disciplines would be involved with the center as needed. However, most centers involved five to eight disciplines (Table 5).

Data given in Table 6 identify the type of research involvement classified by the topic areas commonly encountered in transportation and traffic studies. The interdisciplinary nature of the centers is evident from the fact that a broad spectrum of activities was encountered. Centers did not tend to specialize in one or two select areas but rather provided a broad base of capabilities and utilized individuals from many diverse disciplines. Interestingly, all but one general transportation center indicated participation in transportation planning and transportation engineering, whereas all indicated participation in traffic engineering. All but one of the urban transportation centers noted involvement in urban planning, transportation planning, and transportation impacts. Likewise, all the highway centers indicated involvement in transportation administration, environmental engineering, traffic engineering, and transportation engineering.

Academic Involvement of Center

Of interest is how a transportation center responsible for promoting research and community services relates to academic programs. It is expected that research and academic programs in transportation will develop as mutually supportive elements. Even for centers without direct responsibility for overseeing an academic program, the research component will improve educational opportunities and heighten student interest in transportation. Even though most centers do not directly offer degrees, they provide classes and seminars, coordinate individual student academic programs through advising responsibilities, serve as a central clearinghouse to direct students to respective disciplines for academic programs, and provide financial assistance (Table 7). Thus, the presence of a research-oriented transportation center will provide benefits for related academic programs.

Self-Evaluation of Center

As a guide to others contemplating establishment of a transportation center, it was felt desirable to determine the respondents' reactions to the centers in terms of meeting their objectives. One question asked was whether the availability of a center has led to furthering the interest in transportation in the faculty, students, and local community. In response to this question, the centers were unanimous in their feeling that the presence of a center had helped their programs. Only two of the centers expressed some disappointment in the degree to which it occurred. The benefits derived from the availability of a transportation center, which would otherwise not have accrued, were stated as follows:

1. Encourages expanded research to enhance academic programs,
2. Attracts students,
3. Encourages and facilitates interdisciplinary activity in transportation,
4. Encourages focus on real-world research problems,
5. Attracts funding and visibility,
6. Provides faculty support,
7. Provides for better dissemination of information, and
8. Improves community involvement.

Encouraging programs and attracting students were benefits that were cited most frequently. Providing a better atmosphere for research through interdisciplinary approaches and contact with the community were also mentioned frequently.

Many interesting and thought-provoking replies were received to the question, What factors should be seriously considered before a center is established so that its chances for success are enhanced? Many of the 11 considerations given in the following were identified by more than one institution:

1. For an interdisciplinary program to exist it must not be housed in a specific college. Also place the center in the administrative structure to promote its own budget control.
2. An attractive office and physical plant to encourage interdisciplinary action.
3. Have a full-time director with adequate support staff.
4. Have a continuous commitment from a broad array of sponsors. Do not rely totally on one sponsor.
5. Have a faculty (or at least two individuals) committed to the idea. One of these individuals should be capable of leadership.
6. Provide university funding for base level of support over at least a 3-year period.
7. Ensure administrative support from university.
8. A history of interdisciplinary cooperation.
9. A real need for the services provided by the center.
10. Have guaranteed annual support to maintain the basic organization.
11. Define a focus relying on local strengths to develop a distinctive image and visibility.

Strongest in emphasis were the needs for continuity of funding and not jeopardizing the center by relying exclusively on one sponsor. Also the need for administrative support and the interest of the faculty were noted as critical. For a center to function, it must have a source of leadership and appropriate placement within the administrative structure. If a truly interdisciplinary program is desired, then the center must not be housed in any specific college or department, thus minimizing intercollege and interdepartmental rivalries. Of course, the administrative machinery must exist to permit such a placement.

A review of the questionnaires indicated that "an interdisciplinary approach" represented a common thread identifying how to promote research and training programs in transportation. The strong interdisciplinary ties of the centers now functioning are quite evident from a survey of the disciplinary mixes encountered. The particular mix of disciplines varied from institution to institution depending on local resources and

interest on the part of the faculty to become involved in transportation problems. The centers were then providing the atmosphere and structure where various disciplines could meet to work on common problems. A paper by Romvaldi and Hoel (5) provides further thoughts on how to encourage a truly interdisciplinary effort.

It might also be pointed out that there must be a clearly defined need for a center in order to enhance its chances of success. A number of respondents pointed out the recent trend toward proliferation of centers without sufficient research or student support. It can be said that educators have little appreciation for the demand aspects of transportation program development. Little information is available on how many students various segments of the transportation industry will be able to absorb in future years. Yet independent decisions continue to be made on altering the supply of transportation education without regard for demand. Currently no information indicating the total number of students enrolled in transportation programs is available. Table 8 gives partial information based on a sample of 10 schools. The results indicate that emphasis is concentrated on MS degrees. The point that overcapacity in transportation centers might soon be reached was one warning provided. This raises an interesting question: How can the benefits of a transportation center be extended to other institutions, particularly smaller or undergraduate-oriented programs not currently pursuing sizable research or graduate training programs in transportation? To provide insight into this question requires that the contributions of a center appropriate to a smaller operation be seriously considered. That is to say, for the scale of operation identified by the survey, the transportation center is perhaps the most expedient technique to stimulate research and give a common focus to transportation courses, but alternate directions might be available to better suit the unique characteristics of each institution. A center is frequently established to coordinate elements internal to the university by providing contact with outside agencies and by providing a certain degree of mission identity and visibility. However, curricula and educational formats can be altered as part of internal procedures by any size university and need not be related to concerns for extramural funding.

CURRICULUM

Whether or not a transportation center exists, the question of the types and level of curriculum to be provided in the academic programs needs to be addressed. As experienced educators can attest, curriculum development and change can be quite a difficult area. Changes resulting from the ways in which transportation is being viewed by society can be dealt with most effectively by including in the curriculum material from a broad array of disciplines.

At the same time there is a danger of making the student too shallow in one area so that he does not have the capability of working through to the details of a problem. For example, it may be desirable to give an engineering student background in economics, architecture, biology, urban affairs, and so forth; however, if by doing this he learns so little engineering that he cannot perform ordinary engineering tasks that might be assigned to him, he may be unable to put his broad background to any useful purpose. The key to dealing with this type of conflict is to provide as much flexibility in the program as possible but not at the sacrifice of presenting a core body of information.

There are two basic approaches to the development of a curriculum. The first approach is to offer the student a menu that specifies to him the prescribed sequence of courses he must take in order to qualify for a degree. The choices have been made basically by the management in line with their judgment of what everyone needs. The other approach to curriculum development is a cafeteria approach. Under the cafeteria approach the university lays before the student an array of courses from which he can select his own program. In this way the student can tailor his program to achieve a very close fit to his personal goals and objectives. There is, of course, some danger that the student may select an unhealthy combination.

At UWM the approach used is basically a cafeteria approach combined with a strong advisory input. This approach has enabled accommodation of students with a broad range of interests and backgrounds. In general most students will take a common set

Table 6. Nature of research involvement of centers responding to questionnaire.

Research	Type of Center			
	General Transportation	Urban Transportation	Highway	Total
Transportation planning	6	5	2	13
Urban planning	4	6	2	12
Transportation administration	5	4	3	12
Transportation impacts	5	5	2	12
Traffic engineering	7	2	3	12
Transportation engineering	6	2	3	11
Urban systems	3	4	2	9
Environmental engineering	4	2	3	9
Highway engineering	4	1	2	7
Transportation materials	3	2	2	7
No. of centers	7	7	3	17

Table 7. Nature of academic involvement of centers responding to questionnaire.

Type of Activity	Yes	No
Degrees are offered under auspices of the center	3	10
Center offers classes and seminars	6	7
Center coordinates individual student academic programs with advising responsibilities	9	4
Center refers students to respective disciplines for academic programs	11	2
Center provides financial support such as graduate assistantships	11	2
Center provides financial support in the form of fellowships	9	4

Table 8. Degrees granted in transportation at 10 schools with access to transportation or traffic engineering center.

Degree	1967-68		1969-70		1971-72		Estimated 1973-74	
	No. of Schools	No. of Degrees	No. of Schools	No. of Degrees	No. of Schools	No. of Degrees	No. of Schools	No. of Degrees
Bachelor's	13	2	15	3	21	3	34	3
Master's								
Part time	1	1	3	1	4	2	5	2
Full time	34	5	92	9	83	9	118	8
Doctorate	10	3	26	7	13	6	34	6

of courses with the opportunity to select electives from highly divergent areas identified as professional breadth courses. Probably no two students have taken exactly the same program, but then again nearly all of them have backgrounds in a basic set of core courses. One mechanism for achieving a high degree of flexibility in a program is to establish a "Topics in Transportation" course. Under such a course it is possible to offer students certain material on a demand basis without having to go through an extensive course approval process. It also gives the opportunity to offer material of current interest without filling up a catalog with courses that are never taught. The "Topics in Transportation" course should be frequently taught and in a seminar format.

Another important issue in curriculum development is that of offering programs at a suitable level. University transportation programs could be offered to terminate in a 2-year associate degree, a bachelor's degree, a master's degree, or a doctorate degree. In addition these degrees could also be offered on a full-time or part-time basis. Other efforts could include continuing educational programs in terms of short courses, institutes, seminars, or professional degree programs. A school needs to make some decisions on the potential market and which of these levels to emphasize. Experience at UWM has indicated that efforts to attract part-time graduate students and to offer continuing education programs can have very positive benefits. These benefits accrue to the part-time student and to the community because of the greater expertise he acquires through taking courses at the university. Benefits also accrue to the full-time student and to the faculty members from their contacts with part-time students in giving them a greater understanding of the practical aspects of the problems that exist in the real world and the constraints that exist in dealing with them. Providing programs to accommodate the part-time student may cause scheduling and other problems. However, the benefits can easily outweigh the costs if such programs are consistent with the overall goals of an academic institution.

OTHER MECHANISMS

Beyond the visibility that can be provided by a transportation center, a need exists to develop curricula consistent with the current interdisciplinary approach to transportation problems. Other techniques are also available including seminars, team teaching, class projects, sharing of physical facilities, and use of operational gaming.

Joint seminars can be used as a mechanism for bringing together people from different disciplines by providing a forum for discussion of problems of mutual interest. At UWM such seminars have taken two basic forms. The first type is a community seminar with sessions held in the evening and open to the general public. Usually the seminars involve speakers brought in from outside to discuss problems of general interest. The second type of seminar is an in-house, zero-credit seminar. This seminar is intended as a point of informal discussion for the students and faculty involved in transportation projects at UWM. There are no requirements for any of the participants other than attending the sessions. The program is largely developed by the students and can consist of discussions of ongoing and anticipated research projects, films, or outside speakers. Such activities can be quite useful in encouraging persons from different backgrounds to interact. A related tactic that can be applied is to have persons from different backgrounds share the same physical facilities. Through such sharing, the amount of contact can be increased, and a better knowledge of different viewpoints can be developed.

Another form of interaction between faculty and students of different disciplines can be developed by promoting joint activities of one type or another. These activities might involve the joint teaching of a course by faculty members from different departments, the participation of a number of students from different areas on a joint class project, or simulation gaming of a transportation project. Each of these activities has been tried at UWM, and they all have been successful. A course dealing with environmental impacts was taught jointly by faculty from engineering and architecture. In conjunction with this course and other courses, students have worked together on semester-long group class projects. These projects serve as a technique to illustrate concepts and procedures that are subjects of course materials and as such give the students ex-

perience in working together on a realistic project. Among the projects developed in this way have been rapid transit studies, TOPICS studies, analysis of the transportation problems of the elderly, and development of environmental impact statements. One project of note was the development of a "route location game." This game simulates the activities that are involved in the location of a highway facility through a public hearing. The students assume roles ranging from design engineer to concerned citizen to elected official. The interaction provided through such a process can be highly effective in gaining an understanding of the many facets of a transportation decision.

Activities that bring together persons of different backgrounds to work on a common project that cuts across a number of areas should be encouraged if an interdisciplinary effort is to be developed. These activities may go much further than formal measures such as the establishment of a center in developing a program of a true interdisciplinary nature and can be experimented with at a low cost.

CONCLUSION

This paper has discussed some mechanisms currently utilized for developing interdisciplinary programs in transportation. Attention has focused on the concept of a transportation center, curriculum development, and other techniques. The main thrust of the paper has been to present alternatives that might be considered in the development of a transportation education program. This paper is best summed up by presenting these alternatives as a series of questions. Each question must be addressed by an institution seeking to establish an interdisciplinary approach. However, it must be clearly asserted that interdisciplinary effort does not occur naturally; it requires extensive and continuing efforts, and many alternative procedures exist to assist in implementing an interdisciplinary research and training program in transportation.

1. What are the overall goals and philosophy of the program in transportation? What needs are being addressed?
2. Should a transportation center be developed?
3. At what point in time should a center be developed—at the beginning or when the program reaches a certain size?
4. What will be the functions of a center?
5. What will be the sources of support for a center or a program?
6. What academic disciplines will be involved with a center or program? What is the nature of their involvement?
7. How will a center or program function administratively? Who does it report to?
8. In what educational or training activities will a center or program be engaged?
9. At what levels will training efforts be offered? What is the potential market?
10. What is the balance between research and teaching?
11. In what directions should the curriculum be directed—a menu or cafeteria approach?
12. Should joint seminars and the like be offered, and how will they be operated?
13. What are the opportunities for team teaching, joint projects, or gaming in the program?
14. How will reward structures be established?
15. How interdisciplinary do you want to be?

ACKNOWLEDGMENTS

Acknowledgment is made of those many individuals taking time to reply to the questionnaire. In many cases the responses demonstrated a personal interest in this project and supplied valuable insight based on personal experiences. The aid received from all who responded to the questionnaire is greatly appreciated. This work was produced as part of a program of Research and Training in Urban Transportation sponsored by the Urban Mass Transportation Administration, U.S. Department of Transportation. The results and views expressed are the independent products of university

research and are not necessarily concurred with by the Urban Mass Transportation Administration.

REFERENCES

1. Transportation Research and Education at Northwestern. Transportation Center, Northwestern Univ., Evanston, Ill., May 1971.
2. Hoel, L. Analysis of Transportation Planning Education. Transportation Engineering Jour., Proc. ASCE, Vol. 96, No. TE2, May 1970, pp. 123-134.
3. Pignataro, L. J. An Emerging Transportation Planning Program. Traffic Engineering, Sept. 1966, p. 29.
4. Thomas, E. M. Transportation Research: University Challenges and Opportunities. High Speed Ground Transportation Jour., Jan. 1968, p. 16.
5. Romvaldi, J., and Hoel, L. A. The University and the Interdisciplinary Institute. Engineering Education, Nov. 1971, pp. 128-131.