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Contents

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Changing Perspectives on Transportation Engineering Education

Allen R. Cook, Charles E. Barb, Jr., and Leonard B. West, Jr.

The role of the university, and especially of civil engineering programs, in the education of transportation professionals is assessed in a discussion that focuses on paratransit training needs. A survey of 110 university representatives of the Transportation Research Board indicated that paratransit education is lagging behind in addressing the broader issues of paratransit. It was also found in the survey that most transportation faculties are small (50 percent have one or two people) but that most offer graduate programs. Paratransit may be a harbinger of trends toward a short-term, service-oriented approach to transportation development by people who lack or do not need the traditional transportation engineering and planning skills. Case-study analysis of five leading, experienced paratransit organizations disclosed that individuals with entrepreneurial skills and a motivation to innovate were key factors in the success of local paratransit systems. A set of paratransit curriculum materials that consists of five case-study documents and supporting documents (a case-study overview, a set of selected readings, a paratransit resource guide, and a curriculum guide) is described. These materials are intended for use by faculty, students, and professionals interested in paratransit, can be used in a variety of course formats or by students alone, and are intended to address some of the educational needs in the paratransit field while presenting the broader dimensions of it. Finally, a brief commentary on educational issues is presented.

The role of the university curriculum, and civil engineering programs in particular, in the education of transportation professionals is discussed in this paper relative to one of several changing dimensions in the field. Transportation engineering programs evolved initially from mandates in railroad and later predominantly in highway facilities planning and construction. This entailed the long-range planning and development of transportation systems for a growing nation. In the past decade, however, new dimensions have appeared that may dominate the field of transportation development in coming years. Three dimensions of particular interest are the implications of paratransit development, the implications for transportation development when available resources are finite or declining, and the implications for transportation development if capable individuals are not as attracted to the field as in the past. Paratransit development is the focus of this paper, but it has relevance to the other dimensions as well.

Paratransit systems—carpools and vanpools, dial-a-ride services, and jitney operations—represent new directions in transportation planning. Fundamental to this evolution is the change in viewpoint of the transportation professional from one of looking on transportation as facilities—roads and vehicles—to be planned, developed, and managed to looking on transportation as mobility services to be planned, developed, and managed. As Wachs (1) has commented on another aspect of this evolution,

> During the mid-1970s transportation planners have retreated to a position of uncharacteristic modesty from which they are taking stock of what has happened during the last two decades and are preparing to formulate new approaches for the "post-automobile era." Grandiose proposals for sleek tube trains and monorails are hardly heard any longer, and in their place have emerged a host of "paratransit systems" including jitneys, dial-a-ride systems, vanpools, and other simple transport innovations which are certainly unglamorous by the standards of the 1950s.

In fact, paratransit innovations have proved to be far from simple to implement, and this is one of the challenges for transportation educators. There are other challenges as well.

The professional implications of paratransit are discussed in this paper, starting with the results of a survey of 110 university representatives of the Transportation Research Board on the present state of transportation education, including paratransit, in the United States. This is followed by observations derived from five case studies of leading paratransit organizations and a discussion of an extensive set of curriculum materials developed for university instruction in paratransit. The paper concludes with a commentary and a brief review of our efforts to design a transportation curriculum to address some of the above dimensions and concerns.

SURVEY OF TRANSPORTATION RESEARCH BOARD UNIVERSITY REPRESENTATIVES

This survey was conducted for purposes of providing a guide to the development of curriculum materials on paratransit and for assessing their likely impact on instruction. A questionnaire was developed and mailed on November 1, 1977, to the 160 university representatives designated by the Transportation Research Board (TRB). A follow-up mailing was sent to TRB representatives who had not responded by November 22. Mailgrams were sent to 25 representatives who still had not responded by December 1. A total of 110 questionnaires were returned, 70 percent of the total number of representatives.

Respondents

There were a total of 110 responses from North American colleges and universities, 106 from the United States: and 4 from Canada. Seventy-two percent of all TRB university representatives were in civil engineering departments, and the response rate was highest from engineering faculty members. In response to the question, How would you characterize your predominant professional interest?, transportation planning was most frequently cited. The response to this question is given below (note that multiple interests were cited by some respondents):

Predominant Professional Interest	Response	
	Number	Percent
Transportation planning	52	47
Traffic engineering	37	34
Highway and transportation facilities design	32	29
Other transportation interest	15	14
Other	10	9

Eighty-one percent of the responding schools offer graduate degrees in their transportation programs, and 52 percent offer doctorates. The average number of people on the transportation faculty in the departments of TRB university representatives is 3.1. Half of the

departments contain only one or two people. The distribution of faculty size is given below:

Number on Transportation Faculty in Department of Respondent	Institutions	
	Number	Percent
1	24	25
2	24	25
3	15	16
4	14	15
5	6	6
6	3	3
7	1	1
8	1	1
≥9	7	8
Total	95	100

Attitudes Toward Paratransit Education

Table 1 tabulates responses to the question, How important is paratransit education for the following student categories? The respondents rated the importance of paratransit education on a scale from 1 (not at all important) to 5 (very important). Among the TRB university representatives, paratransit education is seen as more important for graduate and undergraduate students. It was considered most important for graduate students in transportation and students in urban planning and least important for undergraduate civil engineering students and students in business administration. The view that paratransit instruction is more appropriate at the graduate level conflicts with the views of Grecco and Satterly (2, p. 119), among others, who have indicated a need in the transit industry for college-trained managers with bachelor's degrees.

In response to the question, How important is instruction in the following aspects of paratransit?, all of the indicated aspects of paratransit service were considered moderately important (see Table 2). Somewhat more importance was attached to instruction in the modal types and their service characteristics and to implementation issues. Bimodal distributions of responses to implementation issues and the category that includes policy, regulations, labor, and insurance may indicate a recognition by substantial numbers of respondents of the importance of these broader aspects to service development.

In response to the question, What is the appropriate course format for paratransit training?, 60 percent of the respondents felt that the topic should be included as part of a transportation planning lecture course, and 43 percent felt that it should be the subject of a separate seminar or special-topics course. Only 21 percent felt that it should be a separate lecture course.

Twenty-four of the 110 university representatives reported little or no interest in paratransit education. Some major universities simply did not find it to be a topic that is of importance to their academic programs or of local community interest. One professor at a large, urban, eastern university made the following comment:

> Paratransit is one of the components of urban transportation. In large cities it is much less important than standard transit. We are treating it accordingly; transit and traffic engineering design and planning all get more attention.

A professor of business administration commented that paratransit "is not really of academic interest" but training is provided as "a part of our service to the state in providing local technical assistance."

State of Instruction

In response to the question, Please describe paratransit education in your department, 37 of 110 respondents (34 percent) indicated that they knew of no paratransit instruction at their institution. Most of the reported instruction was in existing lecture courses and graduate seminars. In 85 percent of the courses, less than 20 percent of the course content was devoted to paratransit, and most instruction was limited to descriptions of mode types and service characteristics.

Most of the college and university programs that have substantial activity in paratransit are in civil engineering and management. However, significant programs were discovered in nontraditional programs at small schools. For example, in the Department of Safety at Central Missouri State University, paratransit topics are integrated in a number of transportation-safety courses in programs designed for graduate students seeking employment in transportation-safety education and in the insurance industry.

Observations

Recognizing that the selection of TRB university representatives as the recipients of the questionnaire does not ensure that all university faculty interests and attitudes have been represented, we make the following observations on the survey results:

1. Although most transportation faculties are small (50 percent have only one or two members in transportation), 81 percent of the responding institutions offer graduate work.
2. Paratransit instruction is viewed as most important for graduate students in transportation and students in urban planning and less important for undergraduate civil engineering students. The TRB university representatives from some major universities that are engaged in transportation training do not consider the subject academically important for their students.
3. The educators demonstrated little awareness of a need to equip people with the skills needed to implement and manage paratransit services. They tended to see paratransit instruction as least important for students of business administration (or they had no opinion). Similarly, there was little evidence that the educators recognized the full dimensions of the human-services aspects of paratransit service. The questionnaire tended to support the previously discussed hypothesis that most transportation faculty focused their training on facilities development and planning and were not aware of the concerns of paratransit practitioners.
4. We are unaware of previous surveys of TRB university representatives. They appear to be an overlooked resource for guidelines in the analysis and development of transportation curricula.

PARATRANSIT CASE STUDIES

From 1977 to 1979, Cook and Barb developed a series of training materials to assist college and university instructors in paratransit education (3-7). These materials included five case-study documents of leading, experienced agencies that encompassed much of the present scope of paratransit activity. This included agencies active in the promotion of commuter work-trip ride sharing, in coordinating and providing paratransit services for human service agencies, and in providing rural transportation.

Table 1. Response to question, How important is paratransit education for the following student categories?

Student Category	Score Response (no. of respondents choosing rating) 5	4	3	2	1	Mean	No Opinion
Graduate students in transportation	33	32	21	10	3	3.82	11
Urban planning	19	31	26	14	4	3.54	16
Public administration	14	16	26	13	7	3.22	34
Social work	10	17	23	14	8	3.09	38
Business administration	2	9	23	27	9	2.54	40
Undergraduate civil engineers	4	7	32	39	20	2.40	8

Table 2. Response to question, How important is instruction in the following aspects of paratransit service?

Aspect	Score Response (no. of respondents choosing rating) 5	4	3	2	1	Mean	No Opinion
Mode types and service characteristics	39	31	24	7	4	3.89	5
Implementation issues	37	18	28	10	6	3.71	11
Demand modeling for paratransit	18	33	34	11	7	3.43	7
Policy, regulations, labor, insurance	25	19	24	16	9	3.38	17
Social service	15	26	37	19	4	3.29	9

A previous paper on these case studies (8) focused on technology transfer from the federal-policy level to the level of effective local implementation and concluded that there were three key prerequisites: (a) the presence of an effective local mandate for paratransit development (typically the alleviation of traffic congestion and financial savings for local government agencies and private citizens), (b) the presence of an enthusiastic and effective "patron" who is willing to take the initiative to get paratransit services in operation, and (c) staff that have entrepreneurial skills and the motivation to manage and operate these services.

From an educational perspective, particularly with regard to the traditional orientation of civil engineering and transportation faculties toward facilities planning and design, the following observations resulted from these case-study experiences:

1. Paratransit represents a "process of innovation", described above in terms of technology transfer. As an innovative concept it is occasionally resisted by existing institutions—e.g., conventional transit authorities, state departments of transportation, and metropolitan planning organizations. Efforts to incorporate the Knoxville Commuter Pool within the city government eventually failed, in part because some opponents felt that the commuter pool was in competition with the local transit authority. In the case of Brockton, Massachusetts, Dial-a-Bat, local human-services agencies needed to be "sold" on the concept of transportation coordination by Brockton Area Transit.
2. Virtually all of the key personnel in the five paratransit agencies studied had backgrounds in fields other than transportation engineering or planning. Two urban planners were largely responsible for the Seattle-King County Commuter Pool, and experienced businessmen developed and managed the Knoxville Commuter Pool and the services of North Carolina's Choanoke Area Development Association (9, p. 9). In Knoxville, the early decision to recruit experienced managers rather than students and faculty of the University of Tennessee, which was responsible for the demonstration grant that resulted in the Knoxville Commuter Pool, was cited as a key factor in the commuter pool's success (9, p. 9).
3. In keeping with the earlier comment on transportation as a mobility service rather than a facility, it was evident in the case studies that the clients for paratransit services were recognized as individuals with individual needs. Dial-a-Bat's "manager of mobility" was more than a service manager; she knew her customers and was sensitive to their needs and problems. In Knoxville, efforts were under way in 1978 to develop a micro-computer-based commuter information system that would keep track of individual clients. To cite another example, the Cape Cod, Massachusetts, Regional Transit Authority used "rider identification passes" in evaluating the effectiveness of service and in marketing their paratransit services (10).
4. The management of a paratransit operation requires a formidable array of management skills and considerable knowledge of federal funding programs and opportunities, local regulations, vehicle technology, and accounting. In part, this arises from the small scale of most operations (unless a paratransit agency is fortunate enough to be supported by a patron agency that has a knowledgeable staff, as in the case of Dial-a-Bat, which relied on Brockton Area Transit to resolve insurance, labor, and other problems). With regard to Section 147 (Federal-Aid Highway Act of 1973) rural bus demonstration projects, Burkhardt (11) has commented:

> There is more than just a little whimsy to the thought that one should take all the candidates for director of a rural transportation project to the largest lake nearby and hire the one who can walk all the way across. The director (or manager, or whatever this person's title) should possess the most extraordinary talents one can buy, because much of the success or failure of your project hinges on the efforts of this one individual.

Unfortunately, Burkhardt also noted that project directors were "often grossly underpaid."

5. Finally, it was recognized that all of these case studies were, to a considerable extent, personal accomplishments of people who were willing to surmount the obstacles to the implementation of paratransit services.

PARATRANSIT CURRICULUM MATERIALS

The paratransit curriculum materials developed by Cook and Barb (3-7, 12-15) are intended for an audience that includes faculty and graduate students in transportation, urban and regional planning, social service planning, and public administration; federal, state, and local government staff engaged in transportation and human-services planning; and others interested in the development of paratransit services.

We felt that the most effective means for presenting the broader dimensions of paratransit was through the case-study approach. Each case study was structured by using the following analysis framework:

1. Service overview covers the local mandates, the target markets, and the service characteristics. Service characteristics include paratransit modes, service configurations, incentives to patrons to use the services, and productivity measures.
2. Service planning and barrier resolution describes the planning and implementation process. Since para-

transit was an innovative concept in the 1970s, barrier-resolution activities (regulatory, insurance, and labor) were essential parts of the planning process.

3. Organization explores the staffing and management aspects of the local case study.
4. Operations and record keeping describes the information resources required for planning, operations, and marketing of paratransit service.

Each case-study document includes introductory background information on the local setting and concludes with a commentary on the significance and transferability of the local experience. The overview (12) introduces each case study and provides background information on each of the above dimensions in support of the case-study discussions.

The curriculum materials include Selected Readings in Paratransit (13), an annotated collection of 32 significant articles and reports published between 1965 and 1979. The Paratransit Resource Guide (14) is structured to provide the reader with sources of information, (including personal contacts) on paratransit development at the federal, state, and local levels, with emphasis on federal agencies and national information resources. This guide includes definitions of paratransit, pertinent federal policies, annotated introductory overview literature, other information resources (e.g., the Transportation Research Information Service and the National Technical Information Service), legislation, federal agencies with personal contacts, professional organizations and other associations interested in paratransit development, consulting firms and research organizations, foreign sources of information, and a paratransit educator resource list.

The Paratransit Curriculum Guide (15) provides curriculum suggestions for instructors that address a variety of student audiences in different course formats. It also organizes the material by topic area for the convenience of students who are studying the subject on their own. Finally, the curriculum guide includes an annotated set of seventy-two 35-mm slides that provide background material on the case studies.

In summary, these curriculum materials are an attempt to educate students in the broader dimensions of paratransit and provide them with the means for efficiently gaining, and keeping up to date on, knowledge in this fast-evolving field. Limited teaching experience with these materials has demonstrated the effectiveness of the case-study approach. Students have used them as models for researching local transportation problems and institutions. Finally, the Paratransit Resource Guide (14) has increased the ability of the graduate student to understand the paratransit field and get involved in related research activities.

CONCLUSIONS AND RECOMMENDATIONS

Paratransit development relates to the other dimensions of transportation development noted at the beginning of this paper. The promotion of commuter-work-trip ride sharing is an effort to conserve finite resources, in this case gasoline. In all areas of surface transportation service, funding is an increasingly finite resource. This constraint is inherent in transportation system management (TSM)—"making efficient use of existing transportation resources and providing for the movement of people in an efficient manner" (16, p. 42978). Such activities often include paratransit proposals.

The increasing complexity of the tasks that confront transportation professionals seem to be coming at a time when such careers are not particularly attractive to engineers and planners. Salaries are not competitive with those in other fields, and the tasks may not seem rewarding as a professional career. The case studies did indicate that persons with a variety of backgrounds could be successful in the paratransit field.

The concerned transportation educator, it seems, must address the following aspects and issues:

1. Certain evolving trends need to be studied for their relevance to transportation education. The training implications for people who are on the management staff of transportation services need particular consideration. Should training efforts be directed to undergraduate or graduate students and in what disciplines? Should emphasis be placed on postgraduate training and short courses be addressed to practicing professionals? If most transportation faculties are small and dispersed, how are specialized local training needs (e.g., those for paratransit managers) to be met?
2. An even broader analysis is needed, one that starts with an historical analysis of the evolution of transportation engineering education and continues with an evaluation of where we are today, where we should be, and where we are heading. Many professional transportation planners are unfamiliar with the paratransit planning process, the options available, and the principal issues and concerns. Past training, particularly for those with an engineering rather than a planning background, may make it difficult for some professionals to effectively contribute to the process. However, it is often the professional transportation planner who is called on to plan or evaluate the potential for the development of paratransit service. Wachs (1), noting the significance of the appearance of paratransit solutions on the transportation scene and recounting present difficulties with conventional long-range planning, decries the present inability of planners to formulate planning methodologies and development strategies compatible with the times. Gakenheimer and Meyer (17), for example, note conflicts between long-range planners and the TSM perspective of short-range, operational planning. Cutler and Knapp (18, p. 1), commenting on the problems involved in coordinating human-service-agency transportation, imply that transportation planners might have limited perspectives: "Transportation planners view coordination as the defining and redefining of routes and schedules." A program for retraining transportation professionals might deserve serious consideration.
3. There may be a need to retrain faculty as well. Part of the problem may be present faculty members who are trained in the now-obsolete tradition of long-range transportation facilities planning, which emphasizes the systems approach and sophisticated demand models based on past trends that are unlikely to continue in the future. The paratransit curriculum materials discussed in this paper are addressed to faculty as well as students. In view of the limited ability of most small transportation programs to offer much instruction in paratransit, these materials are also designed for self-study.

At the University of Oklahoma, we have come to recognize three tracks for graduate-level transportation education:

1. Transportation engineering, with emphasis on traffic engineering and maintenance management;
2. Transportation planning, to prepare graduate students for staff positions at the municipal, state, and national levels; and

3. Transportation management, to prepare students for management positions in urban and regional transit authorities or service agencies.

The second and third tracks would be open to students who have a background in a nonengineering field such as urban planning. We are also promoting training programs in traffic engineering that are suitable for the local personnel responsible for this work in practice.

In conclusion, the new programs at the University of Oklahoma do not address all of the needs and concerns involved in transportation professional training, nor can this program solve the problem of the unattractiveness of many positions in urban and state transportation organizations. But if the program can succeed in attracting higher-caliber students to the transportation field, regardless of their undergraduate background, it is believed that a significant contribution to the profession will have been made.

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Reviving Railroad Education in the United States: Programs for the 1980s and Beyond

Edwin P. Patton, C. John Langley, Jr., and Michael S. Bronzini

The results of a survey on the modern educational needs of the railroad industry, conducted with more than 90 senior-level members of the railroad industry, government agencies, suppliers, consultants, associations, and universities, are discussed. The consensus view is that the industry's educational needs can best be met by a combination of focused and practical seminars and short courses for present and prospective professional employees, support for enrichment of the railroad content of university course offerings in transportation, a university railroad research program,

and support of fellowships. The railroads are having little difficulty in attracting talented people, but these new employees typically have no specialized railroad knowledge, and this adversely affects job expectations, career motivation, and employee retention. Railroads actively recruit the small number of new graduates who have training in the rail field. The other segments of the industry have greater recruiting problems and correspondingly greater needs for improved education programs. It is concluded that the recommended university programs will have an immediate and positive impact on railroad job recruiting and will help to strengthen innovation in the railroad industry.

As the railroad industry enters the 1980s, events are occurring that are primarily outside its control and that promise to affect it significantly. One is the movement to deregulate, in an economic sense, all surface freight transportation agencies. The other is the energy shortage, as a result of which the relatively fuel-efficient rail roads may have the opportunity to regain former traffic and to attract new traffic if they can satisfactorily meet the service demands of shippers.

Despite what appears to be an improving financial climate for the railroad industry, interested observers such as government regulators, planners, shippers, academicians, consultants, and investors question the capability of railroad management to take advantage of the new opportunities available to it. Sources for the development of future railroad management have attracted the attention of those related to the industry. The question is asked, Are currently used management sources adequate for the coming decade?

In response, the University of Tennessee, under a contract with the Federal Railroad Administration (FRA), has conducted a study of railroad educational needs (1) with the following specific objectives: (a) to determine the extent of the need for future qualified managers and engineers in this country's railroad industry, (b) to determine whether existing educational programs can meet this need, and (c) to recommend programs for resolving any deficiencies.

The study, which was carried out during December 1978 and the 1979 calendar year, concluded that the modern educational needs of the railroad industry can best be met by a combination of focused and practical seminars and short courses for both present and entering professional employees, by support for enrichment of the railroad content of university transportation courses, by a university railroad research program, and by fellowship support.

METHODOLOGY, RESEARCH PLAN, AND PROCEDURE

Primary research sources for the study reported in this paper were (a) interviews with members of the railroad industry, state governments, colleges and universities, industry associations, consulting firms, and various other agencies and (b) solicited materials on railroad in-house and outside educational programs offered and/or supported by the carriers.

Interviews

Because of the exploratory, somewhat open-ended nature of this study, the researchers decided at the start that interviews should constitute the primary study resource. Interviews were held with more than 90 individuals representing some 35 companies, associations, and educational institutions.

Interviews were held both individually and with groups, whichever the interviewer felt would be most effective. Generally, the purpose of the interview was to determine what the individual or individuals perceived to be the rail industry's present and future management needs in operations, engineering, and marketing and the degree of difficulty that would be involved in successfully meeting these needs.

The selection of railroads and of individuals within companies to interview depended primarily on the degree to which the researchers were personally acquainted with managers of the carriers. In choosing individuals, a careful attempt was made to include managers who worked with or were responsible for recently hired employees being trained for future management responsibilities—not the persons who actually carried out the hiring. As a result, fewer than 15 percent of those interviewed were involved directly in personnel and related activities.

Solicited Material

Although the interviews constituted the primary source of information in the study, the team collected a wealth of material on existing educational programs from the carriers and other private and public agencies connected with the railroads and the transportation industry generally.

NEED FOR FUTURE RAILROAD MANAGEMENT

Preliminary Quantitative Estimates

Although a survey of the railroads to estimate future personnel needs was not included in the scope of the study, an attempt was made to bound the size of the potential problem. Railroad employment statistics showed that the total number of executives, officers, and staff varied between 16 000 and 17 000 for the 1971-1978 period. In interviews with railroad management, there was agreement that from two-thirds to three-quarters of top and middle management would have to be replaced in the coming decade. If it is assumed that 16 500 is an average yearly number of managerial and staff people, then two-thirds replacement in 10 years means 10 720 people, or 1072 yearly; a three-quarters replacement means 12 375 individuals, or 1238 annually.

The yearly figures, of course, assume an even replacement rate over the decade. Such an assumption may be heroic. It is anticipated that a majority of the replacements could be required as early as in the next five years. Such a development would obviously increase yearly replacement needs substantially.

In summary, the research team concluded that a definite need exists and will continue to exist in the next 5-10 years for replacement of managerial personnel, but it is virtually impossible to determine an exact annual number. It could vary from more than 1000 to 3000/year.

Views of the Railroad Industry

The researchers interviewed 66 employees representing 15 railroads. It is felt that these interviews constitute the greatest contribution of this study to the literature. The interviewees were candid and open, and all appeared genuinely interested in the study and sympathetic toward what it seeks to accomplish. The interviews included the following areas:

1. The extent of current and future needs in the rail industry in terms of engineering, operations, and marketing managers;
2. The degree of specialization in railroad subjects preferred by the industry in recruiting;
3. The industry's preference for in-house training,

vis-à-vis externally operated training programs, possibly fostered by one or more government agencies; and

4. The effect of the overall railroad image of decline and marginal financial status on hiring for entry-level management positions.

Current and Future Management Needs

For the industry as a whole, 50 percent of the current work force is scheduled for retirement in 10 years. The process has been accelerated for nonmanagement personnel in recent years through various early-retirement programs established by the carriers. Similar programs for management will be instituted, thereby hurrying the day when replacements will be necessary. The interviewees agreed that there would be a substantial need for managers at all levels of the industry in the coming years, but they were also in virtually complete agreement that the industry would be capable of providing its own replacements without any direct government assistance.

Specialists or Generalists

The railroads hire two types of college graduates on the bachelor's level: (a) engineers, primarily civil, but also including mechanical and electrical, and (b) graduates with degrees in virtually every other field of study. Only one carrier had trouble hiring all the civil engineers for which it had available positions, but this reflected its abnormally high requirements during the current period of widespread, substantial right-of-way rehabilitation. All carriers had trouble hiring the required number of mechanical and electrical engineers, but this merely reflected a nationwide shortage of such individuals and was not limited to the railroad industry.

In the second category, which included business, liberal arts, and all remaining majors, the carriers exhibited confidence that they could obtain the number of graduates they required as and when they required them. In fact, in many instances the graduates contacted the railroads for employment and not vice versa, as might be expected. This was particularly true in the case of marginal or money-losing carriers, to which the challenge of providing rail service under difficult circumstances evidently attracted candidates.

Particularly surprising was the carriers' preference for hiring what can be called generalists as opposed to specialists. This preference extended to both engineers and all other graduates. This is not to say that some specialized course work in rail is not helpful as a means of informing candidates on the background and nature of the railroad business, especially liberal-arts candidates and other non-business-oriented graduates. Some amount of rail orientation can accelerate job training and reduce the dropout rate among the newly hired, but, in the opinion of the managers, any advantage of a specially trained individual over a generally trained person would disappear in a year's time. A college record that shows rail or transportation content is often taken to signal genuine interest in the industry.

The managers were concerned about the overall inability of college graduates to communicate effectively or to approach problem solving with a realistic, logical attitude and procedure. An ability to deal with people was another missing ingredient, but most interviewees admitted that this capability had to be learned primarily through on-the-job experience.

In-House Versus External Railroad Training and Orientation

The extent to which the managers opposed the teaching of practical railroad material to hirees by an agency or institution other than the rail industry itself was somewhat surprising. With the usual exceptions, the industry people regarded external educational influences with suspicion, evidently fearing that such teaching might vary from policies and practices regarded as sacred by the individual firms involved.

In the exceptions to the prevailing opinion, some managers emphatically supported the concept of external teaching, primarily as a vehicle for promoting change in the industry. In one particularly informative session, a young operations manager compared the way in which rail-freight-classification procedures would be taught by a railroad with the way in which they should be taught. In the former case, the process would simply be described and be accompanied by a visit to a classification facility. In the latter case, the description and visit would be included but, in addition, the procedure's effect on overall rail operations would then be analyzed and the implications of classification on each road's ability or inability to compete with other transportation modes in terms of price and service would be underscored. The fact that the procedure is extremely costly and causes delays and frequent unreliable delivery times should be acknowledged, yet traditional management probably would regard such an orientation as "rocking the boat" and consequently undesirable.

An alternative favored by several interviewees involved government aid to colleges and universities to establish orientation courses in railroading or to integrate surface transportation topics. A major in railroading or transportation was not necessarily recommended. Again, in dealing with teaching beyond the basic stages, the majority's preference for in-house intermediate and advanced training was reflected.

One alternative suggested consisted of financial support for respected individual professors of general engineering or economics and business courses. These people would not necessarily teach transportation courses per se but would inject railroading into their offerings in the form of examples, arousing student interest in it by their knowledge of and enthusiasm for the mode.

Railroad Image and Its Effect

The importance of the railroad industry's public image in the hiring of future management was raised in virtually all interviews. Not surprisingly, the profitable carriers said the overall image was no problem. Interested students knew which companies were financially stable and so were not affected by the often-accepted public view that all the roads were bankrupt. The marginal carriers did feel image to be a problem in hiring but, once an individual was employed, the problem disappeared. Of some surprise was the experience of bankrupt and money-losing companies. Rather than being forced to seek applicants, these companies were sought out by job candidates. The challenge of being part of a valid mode of transportation that currently finds itself in decline and precarious financial straits attracted individuals who seek responsibility early in their careers while simultaneously supporting a worthy cause.

Most of those interviewed recognized the need to change traditional railroad policies in handling entry-level management. Long hours without overtime pay, 24-hour responsibility, frequent assignment of responsibility without equivalent authority, stifling bureaucracies that discourage innovation, and forced moves around the system one or more times a year all contribute to a relatively high turnover rate among young managers. Furthermore, not only do the carriers have to satisfy the hiree, but they also have to win the support of the spouse and the family.

A few interviewees felt that such changes would not significantly alter the industry or its conditions and that the problem consisted merely of finding the right people.

Significance of Railroad Opinion

The researchers concluded the following regarding the opinions of rail management:

1. Management's reluctance to accept managerial changes in operating and marketing policies and practices, particularly changes advanced by relatively inexperienced employees, is very real. Any change, much less that advocated by a newcomer to the industry, is regarded with suspicion.
2. The industry—particularly the relatively profitable carriers—is suspicious of government intervention in its affairs. Most companies welcomed the researchers, but a few either failed to respond to the request for information or refused assistance outright. Regardless of the companies' reasoning in deciding to help or hinder the research, their attitude must be considered in evaluating various methods by which one or more government agencies can aid future rail education.

The railroad industry is still primarily privately owned and operated. The financial success of most of its member firms, at least to date, is not a function of government subsidy. Thus, its management, which is traditionally independent and conservative, does not have to embrace government programs or the products of those programs. In addition, since rail rights-of-way remain for the most part privately owned, there is not the opportunity for training individuals to build, maintain, and operate the rail infrastructure that there is in highway, water, and air transportation—unless, of course, the industry wants to turn this responsibility over to government, something it has shown little inclination to do.

It is important to recognize that most of present rail management, particularly at the middle levels where personnel decisions are made, is the product of an educational system that provided little opportunity for studying railroad or other transportation subjects. Thus, they may not be able to fully appreciate the advantages to be gained from studies that prepare a graduate to deal effectively with the emerging technical, economic, and regulatory changes that promise to radically alter the railroad business in the medium- to long-term future.

The manifestations of changing circumstances for the railroad industry are numerous. The industry is daily being required to become more responsive to the dynamic nature of the business of providing transportation service. Market conditions in the railroad industry and factors related to competition are undergoing a continual process of change, and the response of the industry to such change must be managed effectively by those who have decision-making responsibility. In addition, the outlook for government regulatory policy suggests that the economic structure of the railroad industry may be subject to change, which emphasizes the need to be able to react to change as it occurs. Another example is the area of technology, where new developments in signaling and communications, railroad power systems, traffic control systems, data processing, automation of rail yards, rail-line electrification, intermodal equipment and services, and the performance of track systems under heavier loads require the attention of engineers and managers who are able to foster innovation. Thus, the expressed opinions of railroad management concerning the need for railroad specialists must be balanced against the fact that engineering and managerial philosophies that guided operations successfully years ago may no longer be valid.

Views of Rail Planners

Rail planners in state governments, federal agencies, and consulting firms have educational needs that differ substantially from those perceived by the railroads. In general, these segments have a greater need for university graduates who have specialized training in rail transportation and in other surface transportation subjects.

State Rail Planners

State government agencies involved in rail freight planning have a great need for experienced and skilled personnel. Unfortunately, there is a shortage of such individuals in state transportation organizations, and the states generally cannot readily hire recent graduates who have the requisite skills. Frequent personnel freezes and increasing resistance to the establishment of new programs are major factors. The inability of states to offer competitive salaries to new graduates, particularly those with master's and Ph.D. degrees, also contributes. Those states that are in a position to hire rail specialists are interested in hiring people who have taken courses in rail transportation and in supporting subjects such as public policy, public administration, and operations research.

Given the problem of attracting qualified personnel from universities and from the railroads, most state rail personnel enter the field from other areas. Typically, people who have been engaged in transit or highway planning, engineering, or administration are recruited to fill positions in the area of rail planning. Since these individuals have very little, if any, rail experience, there is a great need in the states for specialized short courses in rail. Almost any aspect of railroading that could be covered by this means would find support among the state agencies. Courses in railroad operations, railroad engineering, rail cost-accounting procedures, finance, rail regulation, and benefit-cost analysis were frequently mentioned as needs.

Federal Agencies

Federal transportation agencies have less problem in obtaining new hirees than do state agencies. Federal salaries are quite competitive with those available in the private sector. The federal agencies are particularly active in recruiting recent graduates with master's or Ph.D. degrees with a specialty in transportation.

Consulting Firms

Consulting firms are the least constrained of any segment of the industry in terms of their ability to attract and hire qualified personnel in the rail area. Because of the diverse nature of consulting practice, these firms are very active in recruiting people from transportation and operations research programs in the universities. Consulting firms basically want well-rounded individuals who have superior analytic and communications skills. They recruit from the same programs as those described for the federal agencies.

SURVEY OF EXISTING EDUCATIONAL PROGRAMS

A major portion of this study focused on the identifica-

tion of educational programs, courses, or seminars that pertain directly, or are broadly applicable, to the area of railroad transportation. Included were programs offered by universities, railroads, equipment suppliers, and consulting firms and associations. The primary purpose was to develop an understanding of the extent to which rail-oriented educational programs are in evidence, thus providing a firm basis for recommending the types of programs that should be developed or reinforced to meet the projected needs of the industry. Research sources included articles in the trade press, some unpublished research, and personal letters requesting information from representatives of academia, railroads, equipment suppliers, and consultants and interested individuals.

The following types of programs were included:

1. Degree programs—(a) engineering, (b) management, and (c) interdisciplinary;
2. Company programs—(a) railroad in-house and (b) equipment suppliers; and
3. Seminar programs—(a) general and (b) specific.

The degree programs noted in this study were limited exclusively to those offered by colleges and universities throughout the United States. Both regular and cooperative educational programs were considered. Company programs included both those offered internally by domestic railroads and any that have been developed by suppliers of equipment to the rail industry. Finally, seminar or workshop programs could have been offered by any of the groups under study. Included as possible sources of such programs were educational institutions, equipment suppliers, railroads, consulting firms, and various associations.

Research Findings

Several findings of a general nature deserve attention. There is no current, authoritative source of information on educational programs related to the railroad industry. Aside from the fact that there are a number of highly regarded and very visible programs, identifying lesser-known educational programs is at best a hit-or-miss proposition.

Although there are available a great number of educational programs that deal generally with transportation, there are very few that are tailored specifically to the needs of the railroad industry. Instead, the claim is made frequently by those who offer these programs that certain portions of the subject content are applicable to the railroad industry or perhaps that the value to the railroad industry is implicit in the structure of the program.

The number of programs to be considered is diminished substantially if one restricts attention to undergraduate and graduate engineering, interdisciplinary, or management programs; short courses; and seminars. This study does not adopt such a limitation, but it does emphasize the fact that a significant portion of the programs that are reportedly offered are not managerially oriented but focus on providing tools and techniques for skilled and semiskilled railroad employees.

There is no general consensus among executives of the rail industry as to what the industry's educational needs are. For this reason, it is difficult to claim that any of the courses or programs discussed here are of such overriding importance that the industry could not continue to function effectively without them.

Degree Programs

Engineering

The extent to which most colleges of engineering can devote specific attention to the engineering aspects of railroad operations is somewhat limited. For example, an American Railway Engineering Association (AREA) survey of undergraduate curricula related to railway engineering at 99 schools found that, even at the few schools that did cover the subject, no semester hours of required courses and an average of only 4.43 semester hours of elective courses pertained to the topic of railway engineering. Only 15-20 colleges and universities have formal engineering course offerings specifically devoted to railroads. It is possible, however, that the national attention given to the generally deteriorated condition of the track and roadbed of many railroad facilities will encourage greater future academic interest in railway engineering at the expense of the attention now directed toward highway construction.

It is appropriate here to comment on the value of cooperative programs in relation to the educational needs of the railroad industry. Cooperative education is defined as the integration of classroom theory with practical experience so that students have specific periods of class attendance and specific periods of employment. The railroad industry has participated in the program and is an ideal industry to make use of it. There are literally hundreds of jobs in railroading in which a student can learn the industry from the ground up and at the same time perform a useful service. This method of recruitment can supply a steady source of well-trained employees to the railroad industry.

Management

The management category includes degree programs that are oriented toward the management of railroads and rail operations rather than toward the technical aspects of such operations. Such programs, typically found as curriculum offerings in colleges of business administration, colleges of management or administrative science, and schools of management studies, tend to emphasize the economic aspects of transportation and transportation systems in general. Few business schools offer courses devoted specifically to railroad management or operations. Although the principles of rail management receive attention in many programs, such coverage is frequently in the context of the larger transportation perspective. This is not necessarily a deficiency, however, since a sound understanding of the general principles of business management provides a suitable background for those who aspire to careers in railroad management. In addition, familiarity with the managerial and operating aspects of competitor industries should be considered a positive aspect of the student's academic preparation.

Interdisciplinary

A limited number of schools were found to offer relevant interdisciplinary programs. As a complement to existing formal programs, however, it is important to note that an interdisciplinary approach to rail education is evident in the organizational format and research programs of the transportation research centers that exist at a number of leading colleges and universities.

Company Programs

Railroad In-House

Railroads support or provide their professional employees with college or university degree programs, management training and orientation, management development, specialized skills development, and technical education programs. The overall conclusion is that, although there are some differences among railroads, the industry recognizes a wide variety of educational needs and relies on both internal and external sources for the preparation and execution of many such programs.

Individual railroads tend to be informed about and to recruit from specific programs offered at institutions within their respective operating regions. There is considerable disagreement among industry representatives as to the value of degree programs designed specifically to meet the needs of the railroad industry as opposed to more general approaches to the education of potential employees.

All railroads that participated in the personal interviews or responded to the written request for information indicated at least some formal, internal technical education programs. The main focus of this study, however, excluded technical offerings from consideration.

Equipment Suppliers

A letter was sent to a number of manufacturers and vendors of railroad equipment to request information on their education programs or courses. Since equipment suppliers generally focus on the technical aspects of railroading, their educational offerings do not assist the management development process. Virtually all railroads use this source for the detailed and practical technical knowledge needed for job performance.

Seminar Programs

General

The category of general seminar programs includes a wide range of seminar, workshop, or short-course programs that are of general interest to those engaged in the professions of business management and engineering. Although such programs are not designed specifically to meet the needs of the railroad industry, railroad personnel can often benefit from participation in high-quality course offerings of a general (as opposed to a disciplinary-specific) nature. Frequently mentioned examples are the advanced management programs offered by Harvard and Stanford Universities.

Specific

A number of management development and engineering programs are structured specifically to meet the needs of the railroad industry. Five schools in particular—Northwestern University, the University of Illinois, Pennsylvania State University, the University of Tennessee, and Princeton University—are representative of schools that are currently engaged in such programs.

Three transportation management programs that are somewhat more general in nature were cited by industry representatives as being responsive to the educational needs of the rail industry. These are programs offered by Northwestern University, Columbia University, and the Massachusetts Institute of Technology.

ANALYSIS AND CONCLUSIONS

Evaluation of the study findings leads to the following conclusions concerning the future educational needs of the railroad industry:

1. University programs in railroad education will probably never again be large enough to completely fill the demand for new managers and engineers, and this will force the railroads to continue to hire and train graduates with diverse backgrounds.
2. The railroads' practice of actively recruiting the few graduates who have done course work in rail transportation suggests that such individuals are perceived to be potentially valuable and highly motivated additions to their professional staffs.
3. A mixture of academic programs and continuing-education opportunities will be needed to respond to the broad array of railroad educational needs.
4. External teaching of railroad and rail-related subjects is a means of strengthening the industry's ability to innovate in response to a rapidly changing technological and business environment.
5. The expressed opinions of railroad management concerning the need for railroad specialists must be balanced against the fact that engineering and managerial philosophies that successfully guided operations in the past may no longer be valid.
6. Railroads actively use and support external educational programs, particularly those that complement their in-house programs, those that promise to enhance managerial effectiveness, and those that disseminate new technological developments.
7. Some form of introduction to the railroad industry—its characteristics, uniqueness, demanding nature, and problems—should be available to individuals who are considering it as a career.
8. Interdisciplinary skills are desirable for decision makers at all levels of railroad management.

RECOMMENDATIONS

In view of the conclusions reached above, four possible forms of federal assistance that will materially aid railroad education are recommended: (a) short courses, (b) curriculum enrichment, (c) university research, and (d) fellowships.

Short Courses

Short courses would last one week and would take in between a university quarter's and semester's work. Four specific short courses not currently available are recommended: (a) basic transportation, (b) surface transportation, (c) railroad transportation, and (d) railroad engineering. In addition to these, advanced courses of shorter duration that focus on specific technical and managerial subjects should be developed.

The recommended courses would be taught at a junior-senior university level and would be designed for two groups: (a) recent graduates or those entering their senior year who are interested in entering the railroad industry but have not been able to learn much about it either through college courses or work experience and (b) employees of the railroad industry who management feels should broaden their knowledge and outlook as a basis for future promotion (for example, orienting a union member who has management potential toward management's approach to problem solving and decision making). Ideally, these short courses would alleviate the potential shortage of railroad managers in the coming years by making college graduates more attractive candidates for entry-level management positions and by retraining promising personnel who are already part of

the industry for promotion to management positions.

Clearly, there must be a certain degree of professional uniformity in the presentation of the short courses. This requirement is one reason for the direct involvement of the federal government in putting on the programs. For example, they could be offered by FRA or under a program similar to that of the National Highway Institute. But, in view of the rail industry's attitude toward government involvement in activities directly or indirectly related to it, the programs should be organized and presented under the auspices of one or more properly accredited colleges or universities. The U.S. Department of Transportation (DOT) would establish uniform minimum standards to be met and would arrange whole or partial funding of the courses until such time as they become self-supporting or until a decision is made that FRA will sponsor a continuing program in rail education similar to the transit and highway programs of the Urban Mass Transportation Administration (UMTA) and the Federal Highway Administration (FHWA), respectively.

The cost to present a five-day course that involves 30 participants will vary from $10 000 to $40 000, depending on which specific expense categories are included (the latter figure includes course-development costs). This estimate excludes travel and per-diem costs for participants, which would average about $500/person. Most railroads are willing to underwrite these costs for worthwhile programs. FRA might want to consider funding these expenses for government employees.

These estimated cost levels are the principal argument for initial federal support. Because some of the desirable and recommended courses are experimental in nature, most universities and other course offerors would be reluctant to commit significant development resources to them. Federal funding would thus accelerate the process of course development and would keep attendance costs low enough to encourage participation by a wide range of people, including personnel of marginal and bankrupt railroad companies; rail planners employed by federal, state, and local government agencies; and individuals interested in entering the railroad field. The railroads themselves do not fund external course-development efforts but support them by sending paying participants. Thus, once the courses are operating, they could be supported by attendance fees. In this instance, FRA should consider continued funding of attendance fees for public employees and other eligible individuals.

Curriculum Enrichment

The rail industry strongly favors assistance to existing university programs for maintaining and enhancing their coverage of the rail mode. This would have the benefits of keeping the university community involved in the future of the railroads and maintaining the relevance and technical accuracy of university rail-related education and research programs. Funds channeled to university faculty members to improve the railroad content of transportation course offerings would be used for salary support, student assistants, support staff, travel to various railroads and to rail-related conferences, materials, and small, exploratory research efforts. In essence, this program would establish one or more "minichairs" in rail (or perhaps surface) transportation. The trucking and package-express industries and a few other segments of the transportation industry currently support university professorships. FRA should explore the development of similar programs for the railroad industry, perhaps in cooperation with the Association of American Railroads (AAR).

Funding for curriculum enrichment will be attractive to universities if there are assurances of continuity. Universities are somewhat reluctant to accept program specialization in the face of possible funding curtailment each year. This is less of a problem if established programs with existing rail coverage are selected for support. Funding needs vary directly with faculty salaries and with the percentage of program commitment that FRA is willing to invest. The typical annual funding for an enrichment program large enough to have an impact is approximately $40 000/recipient/year. The railroads have indicated their willingness to make available data, case studies, guest speakers, and similar resources but have not shown any interest in providing funding. The involvement of AAR in program development could be instrumental in changing this.

University Research

All segments of the rail industry support the idea of a federally sponsored university railroad research program. Several rail carriers have suggested that the industry could make use of the research results and should be willing to provide financial support (the latter idea, of course, is less attractive to the marginal roads). All interviewees appreciated the educational value and the curriculum-enrichment aspects of such a program. There was also considerable sentiment among the railroads for enlisting the aid of AAR in ensuring the relevance of the research and to provide access to industry data.

There are ample precedents and guidelines for FRA to follow in establishing a university research program. Three existing programs in the transportation area are the Office of University Research (OUR) Program of DOT, the UMTA University Research and Training Program, and the Maritime Administration's University Research Program.

Railroad research projects at universities are most effective if they are funded for a period of one or two years and involve several faculty members and students. Annual funding requests in the range of $60 000-$120 000 would be typical. Annual total funding of $1 million would provide for an average of 10-15 active projects. This number would currently cover most of the institutions that have sufficient rail expertise to warrant support.

DOT already funds some university railroad research under the auspices of the OUR program. However, rail research proposals must compete with projects in all areas of transportation for the limited OUR funds. Furthermore, some meritorious rail research may be too specific to justify OUR support. Universities are sometimes successful in competing for FRA research contracts, but these often lack the long-term commitment and flexibility that are prized elements of university research. The research sponsored by AAR is highly problem oriented and often short term and therefore incompatible with most university programs. For these reasons, a special university railroad research program is necessary if this avenue for improving academic programs is pursued. This option has been found to be highly effective in other transportation specialties; research increases faculty involvement, interest, motivation, and competence, which in turn leads to improved undergraduate and graduate courses and to new short courses. In view of the benefits to the industry, a joint FRA-AAR university research program would be appropriate.

Fellowships

A university research program would provide student funding in the form of graduate research assistantships or funding for undergraduate hourly employees. In place of or in addition to this, grants for railroad education could be made directly. A program of support to individual graduate fellows would require $7000-$12 000/year/fellow, depending on the level of tuition and fees. A $1 million program would fund about 100 graduate fellows. In comparison, FHWA currently offers about 186 fellowships/year for studies in highway transportation.

Again, there are existing models for FRA to follow. Both FHWA and UMTA sponsor fellowships. Their enabling legislation and program guidelines can be useful in structuring a similar program for FRA.

Railroad funding of graduate study is extremely rare, since individual railroads find it difficult to grant an employee a full year of leave and are concerned about losing the employee after they have paid for his or her education. Yet the industry as a whole benefits from the advanced education of its professionals. This is a strong argument for federal funding of railroad fellowships or, for that matter, for funding of the other university programs described above.

SUMMARY

A well-coordinated and government-aided program consisting of short courses targeted to entry-level professionals, enrichment of university curricula, university railroad research, and fellowships for studies in rail management and engineering will meet the modern educational needs of the railroad industry. Annual funding of $1 million would support any one of the following (although combinations are obviously preferable): 40 one-week short courses, 25 rail transportation professorships, 15 university research projects, or 100 graduate fellows. This program would do much to provide the railroads with a new pool of talent, people with strong career motivation and the skills needed to respond to the changing business and technological environment of the railroad industry.

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Program for Certifying Transportation Engineering Technicians

Larry E. Jones

The results of a joint effort by the Institute for the Certification of Engineering Technicians (ICET), the American Association of State Highway and Transportation Officials, and the Federal Highway Administration to establish and pilot-test a program for certifying transportation engineering technicians are summarized. The program that resulted from this effort provides four levels of certification in each of six broad disciplines: construction, design, materials, traffic operations, surveys, and maintenance. Under the program, technicians may be certified by ICET once they demonstrate relevant experience and performance capabilities, as verified by professional engineers and qualified technicians, and satisfactorily complete tests administered by ICET. The certification program was pilot-tested in the state highway departments of North Dakota, Rhode Island, and Utah. These tests were successful, and the ICET certification program is now open to anyone who wishes to use it. A second facet of the joint effort is discussed—i.e., the attempt by ICET to identify training materials that technicians can study to bolster their knowledge in specific fields and to prepare themselves for certification examinations. Numerous training materials were identified. It was found that the International Correspondence Schools offer many courses that are closely aligned with the training needs of transportation engineering technicians.

Highway administrators and personnel managers have for several years discussed the potential values of developing a national program for certifying transportation engineering technicians. Among the benefits they thought could be derived from such a program were

1. Nationwide acceptance of criteria for assessing and determining career status for technicians and technologists in highway transportation,
2. A rigorous means for relating state civil-service position classifications to staff technical capability,
3. A rational basis for collective-bargaining negotiations to help ensure proper recognition of technical competence as opposed to longevity,
4. Increased assurance that work assignments within agencies are based on job proficiency and that demonstrated proficiency receives due recognition across agency lines,
5. Improved work performance and sharpened knowledge and skills that result from a certification program undergirded by appropriate training, and
6. Improved employee morale and motivation resulting from personal satisfaction and from employer recognition of the employee's milestone accomplishments as the employee works toward certification and career advancement.

It was not until July 1974, during the Engineering Foundation Conference on the Assessment of Resources and Needs in Highway Technology Education, held in Rindge, New Hampshire, that it appeared that such a program might eventually become a reality. One of the principal recommendations of the conference was as follows (1, p. 193):

> That local, State, and Federal highway agencies; highway industries; and professional societies, in cooperation with educational institutions, establish performance standards of certification and recertification for technicians and technologists engaged in highway transportation related work.

A specific action taken by the conference provided for the formation of an ad hoc committee to determine the actions required by the respective agencies and organizations to bring about a certification program.

The ad hoc committee presented a recommended concept for a certification program to the American Association of State Highway and Transportation Officials (AASHTO) Administrative Subcommittee on Personnel at the AASHTO meeting in November 1975. The subcommittee endorsed the concept of certification and voted to appoint a task force to take up the work of the ad hoc committee. Their function was to

1. Work with the National Society of Professional Engineers (NSPE) and the Institute for the Certification of Engineering Technicians (ICET) to expand and refine the program and
2. Identify the various tasks in which technicians should demonstrate proficiency to qualify for certification [it was envisioned that this task force would work closely with the project manager to be appointed by ICET under a proposed contract with the Federal Highway Administration (FHWA)].

The first contract between NSPE-ICET and FHWA was signed on April 30, 1976. Under this contract, the original program concepts were expanded and certification criteria for transportation engineering technicians were developed. The transportation engineering technician field was divided into six broad disciplines: construction, design, materials, traffic operations, surveys, and maintenance. For each of the six disciplines, ICET established four levels of certification: level 1, student technician; level 2, associate engineering technician; level 3, engineering technician; and level 4, senior engineering technician.

The next, and probably most difficult, task accomplished by ICET was to break down the technician job duties and responsibilities for each identified position in each discipline into basic components or tasks, or what ICET has termed work elements. These work elements are the heart of the program. Through them, technicians are able to identify areas in which they are most knowledgeable and therefore best qualified to become certified by ICET.

A candidate may enter the program at whatever level he or she demonstrates proven ability and experience. The program requirements are given in Table 1 (2). For each level of certification, candidates must select and pass examinations on a specified number of work elements. Table 2 (2) gives the requirements for the construction field. The other disciplines are quite similar. To attain initial certification above level 1, a candidate must furnish satisfactory evidence of having the work experience required for the level at which certification is desired plus that required for all lower levels. Such experience must be documented according to ICET procedures.

Certification is based on ability to perform specified work elements and on the knowledge and skills required to perform such tasks proficiently. Therefore, firm evidence of actual performance of these work elements by a candidate in a job environment is essential. Certification requires that professional engineers and qualified technicians who have supervised a candidate in the performance of work elements verify that the candidate has actually performed each required work element in a satisfactory manner. After the candidate receives satisfactory endorsement, a written examination is administered by ICET. Candidates may choose work elements that will enable them to become certified at one level in one discipline and at a different level in another discipline.

The examinations administered by ICET are made up of questions prepared by volunteer committees of professionals for each discipline. The committees are responsible for preparing, screening, and validating all questions that are to be included in the computerized question bank maintained by ICET. Before new or revised questions can be entered into the bank, they must be reviewed and approved by the AASHTO task force.

A report prepared by ICET (3) includes the procedures and standards for certification, detailed descriptions of the work elements, and an inventory of available training resources that relate to each of the work elements.

The program development work undertaken under the contract with FHWA was accomplished under the direction, guidance, and coordination of the task force appointed by AASHTO. The program concepts were approved by AASHTO as recommended guidelines.

The AASHTO task force considered the completed program design and detailed job tasks and unanimously recommended that the program be implemented in three states as a pilot project. The intent was to refine procedures and to identify problems that may arise in the states and in other agencies as they begin to use the program. The task force, with the full agreement of the chairman of the AASHTO personnel subcommittee, unanimously recommended that the FHWA contract be extended, with additional funding, for a pilot implementation program. The objectives were to assist the states to use the program, set some direction in the development of training materials to meet the technician's specific needs, and accelerate the projected availability date of the first examinations. Utah, Rhode Island, and North Dakota, each of which was represented on the task force and has a personnel training system with unique characteristics, volunteered to be pilot states. A second contract between FHWA and NSPE-ICET was signed on September 30, 1977.

While conducting the pilot testing phase of the implementation program, ICET staff made several visits to the three pilot states to explain the program to the technicians and to the appropriate personnel and administrative officers. Applications were then reviewed; reference reports screened; examinations generated, administered, and scored; and the examination results returned to the candidates.

Examinations were administered to 104 employees of the pilot states during the first of two test cycles. Several problems were encountered, and questions were raised. Most of the questions were resolved when ICET published a manual (4) designed to assist the technicians and their employers in understanding the application and testing procedures. A second manual (2) was also published by ICET to give employers an overview of the certification program and its many potential uses by employers in the areas of per-

Table 1. Enrollment and certification requirements.

Level	Minimum Full-Time Experience	Verification of Experience	Recommendation Requirements	Written Test Requirements	Form of Certification	Performance Capabilities
1	No minimum time requirement; eligible when ability in required work elements is established	By supervising engineers(s) and/or job superintendent(s) who actually supervised candidate	One from person familiar with candidate's work	No written test	Letter of enrollment; no formal certificate	Beginning-level work under direct supervision
2	At least two years; students enrolled in engineering or technology courses may apply without entering at level 1	Ideally by professional engineer (PE) familiar with candidate's performance or by certified engineering technician (CET) if no PE available	One from person familiar with candidate's work	Written test covering work elements	Certification as associate engineering technician (AET)	Intermediate-level work within specified field under general supervision
3	At least five years total	By PE except in specific instances strongly justified by circumstances of job	One from person familiar with candidate's work	Written test covering work elements	Certification as engineering technician (ET)	Independent work with little or no supervision on jobs covered by standard and complete plans, specifications, or instructions
4	At least ten years total plus actual supervision of one major project	By PE except in rare instances strongly justified by job conditions, in which case ICET may accept alternative verification	At least one recommendation as to character and integrity from PE personally familiar with candidate's job performance	Written test covering work elements; personal interview may be required	Certification as senior engineering technician (SET)	Assistant to PE with authority to act in name of PE in matters in which authority is delegated and engineering precedent exists

Table 2. Work elements listed and required by type and certification for construction discipline.

Certification Level	Position	General Work Elements		Special Work Elements	
		Listed	Required	Listed	Required
1	Student technician[a]	4	3 endorsed from level 1[b]	10	4 endorsed from level 1
2	Associate engineering technician	7	3 already endorsed from level 1 + 6 from level 2 = 9	25	4 already endorsed from level 1 + 2 more from level 1 + 7 from level 2 = 13 to be examined
3	Engineering technician[c]	13	10 from level 3	10	2 more from level 1 + 7 more from level 2 + 3 from level 3 = 12 to be examined
4	Senior engineering technician[c]	9	7 from level 4	Elements in previous levels	4 from level 2 + 3 from level 3 = 7 to be examined
Total		33	26	45	32

[a] No examination required.
[b] Supervisor's endorsement.
[c] Examination required.

sonnel and salary administration, project planning, training, and job assignment of engineering technicians in the field of transportation. Both of these manuals are available from ICET.

During the second cycle of testing, 88 state employees applied for and were given examinations. Additional familiarity with the program by all concerned substantially improved the smoothness of the entire application and testing operation. At the conclusion of the second testing cycle, 17 technicians had fulfilled the ICET requirements for certification and 52 others were quite close to achieving that goal. ICET is preparing a report that will summarize the results of the pilot implementation program.

The AASHTO task force reviewed the preliminary results of the pilot testing at their April 1979 meeting and recommended that the program immediately be opened to state, local, federal, and private employers and technicians.

The ICET certification program has built into it the flexibility necessary to keep it responsive to ever-changing and expanding requirements. Since the entire program is based on work elements, by changing or adding to the list of work elements the program can be manipulated to handle all foreseeable requirements that may be placed on it. Among the requirements being addressed at this time is the need for qualified technicians to inspect the more than 550 000 bridges in the United States. A special committee has been formed to review the existing work elements to identify those that match the work being performed by bridge inspectors. Where necessary, the committee will draft additional work elements that, after being approved by the AASHTO task force, will be incorporated into the program. Technicians may then become certified as bridge inspectors by passing a specified number of these work elements.

During both the first and second contracts, ICET has sought to identify training materials that technicians could study to bolster their knowledge in specific fields and to prepare themselves for examinations to become certified. As part of the first contract, many individual training materials from various sources were identified and listed (3). Each training resource was cross-referenced to the work element or work elements that were most applicable to the material. Many state highway departments indicated that they had good training materials on their shelves; some were willing to share with others, but some could not because of budget and staff limitations. ICET simply did not have the resources to review and evaluate all of the materials identified.

Traditionally, transportation engineering technicians have received their education and training in on-the-job training programs, technical schools, or classes conducted by the employer. In order to be able to make

recommendations on training, it was deemed desirable for ICET to explore a number of other training possibilities. These possibilities narrowed down to a new concept called "minicourses" and the better-known correspondence method of course delivery. Audio-visual-based training packages were considered to be quite effective, but ICET felt that the cost of providing these materials to a large number of technicians spread across the country—some in remote areas—made them comparatively expensive.

The difficulty and, again, the expense of keeping materials current and an apparent duplication of effort in developing materials on the same subject matter warranted an examination of the concept of a minicourse constructed as an inexpensive manual. ICET prepared drafts of 24 different minicourses structured to correspond to specific work elements. The courses were reviewed by practicing engineers and technicians in state, federal, and private engineering offices. In the feedback received from these reviewers, they supported the concept of the minicourse approach but cited numerous problems with the course drafts. The nature of the problems reflected the need for considerable expertise in selecting and presenting the topical content in ways that were valid in different states and employment situations. This expertise could only be developed over a considerable period of time.

ICET, supported by approval of the minicourse concept but lacking in expertise to develop the training materials in-house, contacted the International Correspondence School (ICS) of Scranton, Pennsylvania. It was found that ICS had been using the job-task-inventory approach to training (similar to work elements) for many years as a means of increasing educational effectiveness and efficiency. Because of the apparent compatibility between the ICS program and the training requirements needed to support the ICET certification program, the AASHTO task force recommended that NSPE and ICET work with ICS to establish a major training resource for all transportation engineering technicians employed in both the public and private sectors. NSPE followed through and signed an agreement with ICS to implement the task force's recommendation.

ICS is currently cross-referencing all of its existing training materials to the applicable ICET work elements so that they will be prepared to advise prospective students as to which of the ICS courses would be most appropriate when technicians are seeking certification in a particular field. ICS is not envisioned as the sole source of training materials for students who are preparing for ICET certification. But it has been identified as a readily available source of training information for many of the work elements.

From the very beginning, the development of the technician certification program has benefited from the support and participation of a substantial number of individuals. Private as well as public-agency employees have participated because the construction and maintenance of the national transportation system is a massive project that involves millions of people and billions of dollars. Technicians are the backbone of the transportation system; an estimated 750 000 of them are employed in highway-related activities alone. Motivating this work force—e.g., in the identification of areas in which additional training may be needed to support career-development plans—is extremely important.

The Certification Program for Transportation Engineering Technicians has definite potential for improving the work performance of technicians and ultimately improving the national transportation system overall. The decision to take advantage of the program rests with technicians and their employers.

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Training and Education in Transportation: Future Directions

Lester A. Hoel and Michael D. Meyer

The dramatic changes in the environment in which transportation professionals operate in the United States and the impact of these changes on transportation education and training are examined. Within a decade, the definition of the urban transportation "problem" has been expanded from one focused solely on congestion to one that includes at the very least the relationship between transportation and the following factors: energy, air quality, equity, safety, congestion, land use, noise, and more efficient use of scarce resources. These new problem definitions and the skills necessary to deal with them effectively have added to the responsibilities of transportation educators and represent forces of change in U.S. educational programs. Actions that could be taken to prepare for the future professional needs of the transportation sector are recommended.

The environment in which transportation professionals operate has changed dramatically during the past 10 years. During this time, we have seen the definition of the urban transportation "problem" expand from one focused solely on congestion to one that includes at the very least the relationship between transportation and

the following factors: energy, air quality, equity, safety, congestion, land use, noise, and more efficient use of fiscal resources (1, 2). In the private sector, we have seen an increasing interest in the application of technical and management skills to problems in the air, rail, and trucking industries.

This paper examines what impact these changes have had and will have on transportation education and training in the United States. The results of a survey that asked representatives of universities about existing and future education and training programs are presented. Special emphasis is placed on what directions these programs must take if the future needs of the transportation sector are to be addressed. The paper concludes by recommending increased interaction between educators and practitioners to identify and prepare for the education and training needs of transportation professionals.

EVOLUTION OF TRANSPORTATION EDUCATION

It has been only a few decades since state highway departments were concerned almost exclusively with rural, intercity roads. Indeed, it is only in recent times that state highway agencies—many of which are now state departments of transportation (DOTs)—have been concerned with broader issues than simply the construction of major highway facilities. Examples of these new issues include highway maintenance, increasing passenger flows on existing highways, and citizen involvement in decision making. Furthermore, highway and transportation agencies are also being asked to systematically identify a wide range of possible direct and indirect social, economic, and environmental effects of proposed actions (3).

The changes that have occurred in the organizational environment of highway agencies are indicative of the changes that have occurred throughout the transportation sector. These changes pertain not only to the types of projects being considered but also to the analytic methodologies that are used, the objectives that are met, and the actors who are involved in the process. For example, one of the most significant changes in urban transportation in recent years has been the shift toward planning that is service oriented rather than facility oriented, involves relatively inexpensive actions, and seeks the most efficient use of existing facilities (4). This new planning emphasis not only causes problems of methodology but also creates a need for greater coordination and cooperation among the many agency staffs that have a significant role to play in the transportation planning process.

The major changes that have occurred in the methodological framework of urban transportation since 1945 can be summarized by phase, as follows:

1. Conceptual development (World War II to the 1950s)—(a) new techniques, (b) impact of transportation on land, and (c) sequential demand models first available;
2. Operational development (1950s to the early 1960s)—(a) large-scale transportation studies, (b) Bureau of Public Roads manuals and codified models, (c) Federal-Aid Highway Act of 1962, and (d) complex land use models;
3. Stability (1960s)—(a) consolidation, (b) analytic approach to urban transportation planning, and (c) land use and travel demand;
4. Upheaval (late 1960s to the present)—(a) revolt against highways, (b) public transit, (c) greater importance of external factors, (d) relation of transportation policy to other urban policies, and (e) nonoptimal solutions; and
5. Transition (the present)—(a) institutional change, (b) long-range and short-range interaction, (c) incorporation of other planning concerns, and (d) types of projects and strategies.

This chronology reflects the changing skills and styles of analysis that have been needed in different eras to address the issues as they were defined at the time. During the years after the Second World War, most programs in transportation education focused almost exclusively on the teaching of engineering design and project construction. The systems-analysis tools that were being developed during that period had not yet been introduced in a major way into the academic programs of transportation students. The product of undergraduate programs in transportation engineering was a person capable of designing, constructing, and operating the physical facilities that were being developed throughout the country.

Later, as regional transportation studies became an increasingly important component of the urban transportation planning (UTP) process, new skills and techniques were required to implement the computer-based methodologies and analytic approaches necessary to successfully complete such studies. Many universities began active research programs in these topics and incorporated much of the material in new courses on transportation systems analysis and transportation planning, at both the undergraduate and graduate levels. During this period, many schools expanded their focus from basic engineering design to include new topic areas in transportation planning and analysis (5). The transition from engineering-design programs to programs emphasizing a systems-analysis approach occurred more rapidly at some institutions than at others, and the dichotomy in program objectives became very evident during this phase.

During the late 1960s and early 1970s, public opposition to many highway construction projects, increased funding for public transportation, and an increased awareness of the external impacts of transportation facilities created a need for transportation professionals with special skills and attitudes. There was a need for people who understood public relations, who could investigate the environmental impacts of transportation facilities, who were able to manage and operate (as well as construct) public transportation services, and who understood the political environment in which transportation agencies operated. In response to these new needs, many universities adopted a multidisciplinary approach to transportation education, and some developed special training programs for professionals who had been educated in an earlier era. These programs were less oriented toward design and computer modeling and tended to emphasize transportation planning in its broadest sense. During this phase, transportation research and training were often carried out in an institute or center context (6).

Now it appears that transportation education is once again in a transition period, during which the changing definitions of transportation problems will require new skills and knowledge of future transportation professionals. We may be entering an era when the transportation system is in place, and the challenge may be to improve its utilization and physical condition. Many factors that are external to the transportation system itself but that directly affect it may contribute to fundamental changes in the system as we know it. It is too soon to say how, if at all, the focus of some transportation education programs will change to reflect

this. Early indications are that the general area of transportation system management, in both the public and private sectors, will be receiving increased attention in academic programs. If this trend materializes, management will soon join planning, systems analysis, operations, and engineering design as another characteristic aspect of transportation academic programs in this country.

The discussion illustrates the relationship between the changing environment of transportation and the transportation education process. The changes described are general in nature and do not reflect the wide diversity in academic programs and research efforts. In addition, we are looking at major trends while at the same time recognizing the need for professional skills in each of the major areas—planning, systems analysis, operations, engineering design, and management.

It is difficult to draw general conclusions about transportation education in the United States. Each university has its own philosophy of what constitutes an appropriate education in transportation and its own limited resources for providing this education, and each operates under different pressures. However, it is important to recognize that the transportation field has undergone major changes during the past decades and will likely change even more dramatically in the future. Transportation education will no doubt respond as it has in the past, with new courses, new mixes in programs of study, new research topics, and special educational and training programs. Demonstrating leadership in the academic community in identifying and addressing future transportation issues and imparting to students the qualities needed to meet new and exciting problems are continuing challenges in transportation education.

UNIVERSITY PERSPECTIVES ON TRANSPORTATION PROGRAM DEVELOPMENT

There are many examples in the literature of actions that individual schools have taken in developing transportation programs and surveys that have been taken of employers and practitioners to determine whether engineering graduates exhibited the required competence. In the first case, authors have focused on the relation between research and multidisciplinary educational programs (7), the broadening of civil engineering (especially transportation) education to expose students to the planning and policy aspects of engineering (8, 9), the need for interdisciplinary solutions to engineering problems (10, 11), and the functions and components of specific programs in transportation (12). A second area of discussion has been the continuing educational needs of the engineering professions (13-15).

Both of these areas are important and deserve further attention from the transportation profession, but neither really addresses the issues of what type of professional the transportation education process should produce and what forces are at work within universities that limit their ability to do so. The first step in addressing this issue was taken at the 1973 Highway Research Board Conference on Multidisciplinary Education in Transportation. The purpose of the conference was to discuss the problem of providing such multidisciplinary education and to provide a means for educators to communicate their approaches and experiences to one another. The five general conclusions reached by the conference, which highlighted many of the problems faced by transportation educators, serve as a useful point of departure for this discussion. The conference participants concluded the following (16):

1. A new profession and discipline of transportation had come into existence during the past 20 years. The nature of the discipline was multimodal, relied on a variety of methods and techniques, and was based on several theoretical bodies of knowledge.
2. Transportation education, although it had responded to many changes in the past, was still not satisfactorily addressing many of the problems that were facing the discipline.
3. Transportation educators were better prepared than their predecessors but still could not agree on the overall goals of a transportation education program nor on the means to be used in achieving them.
4. The two major disciplines in transportation—engineering and the social sciences—were frequently at odds with one another. One of the reasons for this was the lack of communication between the two groups.
5. University administrations did not recognize any special place for transportation in the university structure. Administrators pointed out the need to respect already-established disciplines, maintain university structure, consider university budgets, and remember the broadly conceived objectives of the academic community.

Several conference participants also proposed key components of graduate transportation education programs that would expose the student to a broad range of issues. More importantly, however, some participants presented an outline of the type of student the education programs were trying to produce. Harris (17), for example, suggested that students should be well equipped to achieve three objectives:

1. Establish a basis for further acquisition of knowledge if this proves a professionally desirable step.
2. Deal intelligently with skilled professionals in the field and especially know how to avoid the imposition of bad advice; and
3. Understand the limitations of their own knowledge and the extent to which they are unable to wisely make major decisions and judgments.

Manheim (18) argued that the transportation professional must have expertise in three major areas: technology, interactions between technology and society, and role perception and capabilities. Pignataro (19) stated that education should prepare a student to become "an effective decision maker without the need for a vast amount of experience upon which to base the decisions." The educational program, Pignataro concluded, must therefore be concerned with the problems and issues that transportation will face in the future. Webber (20) viewed the task of the transportation planner as being one of "fueling" political debate by providing analyses and forecasts of likely alternative outcomes and by asking sharper questions that will engage more public groups in the dialogue.

CURRENT PERSPECTIVES ON TRANSPORTATION EDUCATION: RESULTS OF A SURVEY

The views of the product of the educational process reported in the literature clearly reflect significant differences of opinion on what a transportation education should accomplish. Are there such differences in point of view today? What substantive areas of knowledge are graduate students in transportation exposed to in their academic careers? What types of jobs do

students accept upon graduation? What do transportation educators think will be the major transportation policy issues in the next decade? And what constraints do professors face in providing the type of educational program that they think is necessary to prepare the students who will eventually deal with these issues?

To find answers to these questions, an informal telephone survey was conducted with 20 Transportation Research Board (TRB) university representatives (some from nonengineering departments) from schools that have large, well-established transportation programs as well as those that have smaller programs that have only recently been established. The sample was not large, nor were the questions structured to allow statistical comparisons between the schools; yet the survey was helpful in gaining some insight into how educators currently view trends in transportation education.

The questions asked in the survey and the results obtained are discussed below.

Required Courses

Respondents were asked, What substantive areas of knowledge are graduate students in transportation exposed to through required courses? Among schools that had a required core of courses, there was almost unanimous agreement on the type of courses included. The primary focus of the core courses was on developing a familiarity with analytic methods and other tools of analysis. In most cases, this meant courses in systems analysis, microeconomics, statistics, and operations research. In the planning-oriented schools, transportation planning was also required, whereas the schools more oriented toward engineering required a course in traffic engineering. What was somewhat surprising, however, was the relatively large number of graduate programs that did not have required courses. In these programs, the students were given a great deal of flexibility in choosing the types of courses that made the most sense for their career objectives. Nevertheless, in many cases students ended up selecting a common transportation core program. The type of courses in the transportation core program have not significantly changed in the past five years. Most respondents stated that any new change in the transportation field is incorporated into the material of existing courses.

One school, however, had developed a completely new program in transportation that included core courses not only in analysis methods but also in management and transportation institutional analysis. This program was clearly the exception.

Type of Graduate Desired

Respondents were asked, What type of transportation professional are you trying to produce in your graduate program? The existence of a core set of courses is usually indicative of what the faculty views as the necessary skills of a transportation professional. However, this question caused the greatest amount of hesitation on the part of the respondents, partly because of the ambiguous nature of the question and partly because, as some respondents commented, they had never thought about it before. The answer most often given was that a graduate of the respondent's transportation program should be skilled in the use of quantitative methods but also aware of the arena in which the transportation planner-engineer operates.

Upon further questioning, it was also discovered that most of the transportation graduates end up employed in the public sector or with consulting firms that conduct most of their work in the public sector. This was not surprising to most respondents, given the little emphasis placed (in educational programs) on the role of the private sector.

Problems Anticipated in the 1980s

Respondents were asked, What do transportation educators see as the major problems facing transportation during the next decade? The following list summarizes the problems identified by transportation professors (listed in order according to the frequency with which they were mentioned):

1. Better management and operational control of existing transportation systems,
2. The relationship between transportation and energy,
3. Maintenance of highway facilities,
4. Provision of adequate public transportation services,
5. Intercity transportation, and
6. Improvement in traffic safety.

Many respondents readily admitted that they had not given much thought to the transportation issues that would surface in the future because they were busy trying to address problems that had already been identified.

Constraints on Curriculum Development

Respondents were asked, What constraints do professors face in developing the type of educational program that they feel is necessary to produce the transportation professionals who will deal with future transportation problems, and are there any recommended courses of action that will help to loosen these constraints? This question sparked lively discussion about educational objectives and how the academic program has been set up to attain them. Most respondents focused on the limited availability of funds, which greatly constrains what they teach and the research they can do. Funds for basic research in transportation are nonexistent, as are funds for significant efforts at changing the transportation curriculum in order to adopt new orientations and incorporate new problem statements.

Although the university representatives came from a wide variety of schools, they all spoke about the overwhelming importance of research in their career development and complained about the shrinking funds for research support, the trend toward higher levels of required research support, the need for professors to search for problems rather than being visionary, the largest source of research funds coming from federal agencies that many felt did not have the right perspective on the issues, the increased demands by state legislatures for more teaching at the undergraduate level but with no additional financial support, and the increased pressure to do outside consulting to make up for the market differential in salary. Several professors also noted the difficulties they had in finding support in other disciplines for interdisciplinary studies of transportation problems.

Suggested courses of action that would address many of these issues included

1. Divide the existing U.S. DOT research funding programs into two major areas: (a) funding of problem-oriented, applications-focused research that is characteristic of existing programs and (b) funding of basic,

innovative research aimed at defining future issues and possible solutions;
2. Develop a new research grant program that would accomplish the second purpose stated in the above proposal;
3. Organize on an annual basis a one- or two-week session in which transportation educators and other transportation professionals would discuss future directions of transportation in the United States;
4. Change the incentive structure in the universities to encourage more interdisciplinary approaches to transportation problems; and
5. Given that most of the previous proposals require some significant changes (and are thus not likely to be implemented), incorporate transportation researchers and educators more heavily in the initial governmental development of research statements.

Because there is such a strong link between research and academic programs, most respondents focused on increasing the flexibility of research programs with the assumption that academic programs would naturally benefit.

FUTURE ISSUES IN TRANSPORTATION AND TRANSPORTATION EDUCATION AND TRAINING

As the response to the survey illustrates, the focus of programs in transportation education has changed very little in recent years and, what is more, transportation educators feel that they are too severely constrained in both time and resources to be visionary in identifying future problems and potential transportation solutions. A recent report of the National Transportation Policy Study Commission (NTPSC), however, suggests that future issues in transportation will continue the trend toward rapidly changing problem definitions and, thus, a reliance on nontraditional types of solutions (21). The following 10 issue categories were listed in the NTPSC report as the more important problems to be resolved by U.S. transportation policy through the year 2000:

1. Government policy mechanisms—What mechanisms can the government use to achieve its transportation objectives in the least intrusive manner?
2. Government regulation—What role should the government have in regulating the transportation industry? In addition, issues of air, water, and noise pollution and environmental-impact-statement procedures need to be addressed.
3. Government finance—How should government provide the necessary funds to support transportation systems (if at all)?
4. Highway system management—Which levels of government should be responsible for funding various portions of highway "needs"?
5. International transportation—What transportation policies should the U.S. government follow in international trade?
6. Public transportation—How will adequate public transportation be provided? Who will pay for this service?
7. Transportation technology—How should sufficient levels of research and development be provided so as to ensure technological advancement in transportation?
8. Intergovernmental relations—What institutional relations should exist to encourage effective policy-making and implementation?
9. Energy and transportation—How can transportation systems provide the most energy-efficient movement of people and freight at the least social and economic costs?
10. Economic development and land use—How should decisions on transportation investment be related to impacts on community development (and vice versa)?

Although these issues were identified as topics that must be addressed by the federal government, most of them will have a significant impact at all levels of government and will thus require some attention at these levels as well. Furthermore, it is clear that the resolution of these issues will require concerted efforts by government, industry, and academia and will also rely heavily on the ability of transportation professionals to draw on a diverse background of skills and insights that cut across most traditional disciplines. An educational program that prepares a student for the types of issues to be faced, the ways in which the issues can be addressed, and the role that he or she has in both the technical and political processes that are used to resolve the issues is an important first step in the development of a group of transportation professionals who will effectively participate in future transportation decisions. Also important in this regard is the provision of opportunities for professionals who received their education and training in one area to reeducate themselves, given that the transportation problems as seen by society have become quite different from those discussed in graduate school years.

The issues outlined in the NTPSC report will clearly be important topics for research and thoughtful consideration, but do they represent topical areas that should receive substantial exposure in educational programs? Perhaps they are not specific course or subject material, but they do represent new areas of application for existing analysis methods and in many cases will require new methodologies that must be developed to address a changing perception of what the real problems in transportation are. Although we do not purport to have any significant insight on future problems in transportation, we do offer the following list of substantive areas of investigation that could well be incorporated into academic (and research) programs.

Project and Program Implementation

The transportation profession has focused almost exclusively on the design and evaluation aspects of transportation projects and programs in the past. Given the politicization of the transportation planning process in the 1970s and the new types of transportation strategies being considered, understanding the barriers to successful program or project implementation and developing implementation strategies that will take these barriers into account are becoming important skills for the transportation professional. An effective approach to teaching this material should include exposure to political science and organizational studies, although most transportation educators could, without formal training in these disciplines, do a good job in highlighting many of the important implementation considerations.

Institutional Analysis

The institutional type of analysis is closely related to many of the concepts discussed as part of the implementation issue. Although it is a relatively new area of study, institutional analysis will become more important in the next decade as the focus of transportation issues turns to decision making and implementation. In

essence, institutional analysis is a study approach that uses elements of economic, political, and organizational theory to identify administrative and political factors that affect the formulation and implementation of policies, programs, and projects. The value of such an approach to a transportation professional is that it is helpful in (a) understanding current institutional interactions and thus being able to identify key structural variables that constrain innovation and/or implementation, (b) identifying strategies of institutional change that would not only be effective on a limited scale but would also greatly contribute to the understanding of larger-scale innovation, (c) contributing to the formulation of an effective implementation strategy for transportation programs and projects, and (d) predicting the effects on organization output of a change in organizational structure.

Operational Planning

The methodological balance in transportation planning has started to shift away from the analysis methodologies related to large-scale facility construction toward analysis approaches that examine the operational characteristics of transportation systems. This shift is likely to continue in the next decade. Operational control strategies and operational planning will thus become important areas of education and research.

Management

Many current U.S. transportation policies are related in some way to the management of transportation properties. Management skills are needed not only in public-sector agencies but also in transportation firms in the private sector. Many graduates of transportation programs end up in management roles and are often unprepared for the type of work that they must do. Budget, administration, decision-making authority, and functional responsibilities are issues that underpin many of the problems in the transportation sector, and yet these are issues that many transportation graduates know very little about.

Role of the Private Sector

One of the surprising results of the survey was that most transportation graduates of the surveyed programs ended up in public-sector or public-sector-related jobs. Further questioning made it apparent that the transportation students were not at all exposed during their academic experience to the role of the private sector in transportation and in other sectors of the economy. The focus was clearly on methodologies but, more importantly, on methodologies that would be applied in public-sector contexts. This is the issue area in which changes in the transportation environment will probably be most dramatic. The private sector already has an important role to play in transportation and economic development in this country, and its role is likely to increase during the next decade. Thus, the transportation student who learns about planning methodologies and the heavy reliance of planning procedures on federal planning regulations but who does not understand the motivation of private developers and their influence in the political decision-making process is in for a rude awakening on his or her first job.

Decision Making

The final area of academic pursuit, which some have placed at the top of their priority list and others think it inappropriate to even address in an educational program, related to two questions: How are decisions made? How should decisions be made?

The focus of current transportation education is on the understanding and use of analysis and design methodologies that will be used by the student once he or she leaves the university. This is indeed a most appropriate focus for an educational program. However, the danger of an overemphasis on methodology is that the first question students are taught to ask is what analysis techniques will be useful to address the problem rather than what the underlying problems are that need to be addressed, what decision-making process will be used to make a final decision, what information is needed in this decision-making process, and then what type of analysis techniques will be used to provide the necessary information.

Summary

These six areas of investigation could be usefully applied at all levels of transportation planning and analysis—federal, state, regional, and local. Although these areas do rely on interests and expertise not usually found in programs in transportation education, they do represent major new areas (methodological and otherwise) that will be facing transportation and transportation education and training in the 1980s.

CONCLUSIONS AND RECOMMENDATIONS

Transportation education and training in the United States have changed over time to reflect the different problem perceptions and methodological developments that have occurred throughout the history of transportation. In most cases, however, this change has occurred slowly and only then in response to the changing environment of the profession. Furthermore, change has not been uniformly adopted by all universities, and this has resulted in different schools viewing themselves as producing different types of transportation professionals. Some transportation programs remain oriented toward engineering design and operations, whereas others focus more on systems-analysis applications and still others are more oriented toward planning.

This paper has shown that dramatic changes have occurred in the emphasis of transportation problems during the past and has suggested that even more dramatic changes are likely to occur in the future. Will some programs in transportation education now head in another direction to reflect this rapidly changing environment? Some programs are indeed starting to change their focus by incorporating greater concern for system management into the curriculum, but it is still too soon to identify this as a major trend.

The survey of TRB university representatives resulted in the following observations:

1. The substantive areas of knowledge that graduate students were required to take in those programs that included required courses were almost exclusively related to developing a familiarity with analytic methods and other tools of analysis. In most cases, this meant courses in systems analysis, microeconomics, statistics, and operations research.
2. The most common means of incorporating new ideas, methodologies, and problem statements into the educational program was by modifying existing courses. The types of courses in the core of most transportation programs that were investigated, however, had not significantly changed in the past five years.
3. Transportation educators agree that a graduate

of their program should be skillful in the use of quantitative methods but should also be aware of the arena in which the transportation planner or engineer operates.

4. Most of the transportation graduates of the programs surveyed end up in public-sector or public-sector-related jobs.

5. The major transportation issues identified as those that need to be faced in the 1980s are similar to some of those identified in the NTPSC report (21). The several omissions can be explained by an unfamiliarity with these types of issues among those surveyed.

6. Several constraints—both intrauniversity and external—hinder the development of an educational program that can produce professionals who have the necessary background to address the new transportation issues. A lack of funds and of appropriate research projects was viewed as being critical in this regard.

Finally, we feel that the following are some of the major issues to be faced by the transportation profession in the next decade that can be addressed in an educational program: problems of project and program implementation, institutional analysis, operational planning, management skills, the role of the private sector, and the decision-making process.

This paper has raised questions about the focus of programs in transportation education in this country and the ability of the academic community to identify issues of substance that are likely to dominate the transportation field during the next 10 years and beyond. Clearly, however, every school is different in what it is trying to accomplish and the constraints it faces in doing so. Therefore, recommended courses of action, no matter at what level, will probably not address the issues that some schools are facing and might even be in conflict with the goals of other schools. The concerns raised in this paper, however, can be addressed by opening a dialogue between educators at different schools and between educators and practitioners on the types of education programs needed in the transportation field. Although there are many ways in which such a dialogue could be encouraged, we feel that more effort by transportation research organizations such as TRB and by academic institutions in sponsoring symposiums or conferences that focus on these issues is a necessary beginning.

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