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Transportation Workshop for Minority Institution Faculty

ROBERT E. PAASWELL, LOUIS J. PIGNATARO, NATHANIEL JASPER, JOHN FALCOCCHIO, AND ROGER ROESS

A summer workshop to train faculty from minority institutions in various aspects of transportation research was held in the summers of 1980 and 1981. The purpose of the workshop was to generate a greater response from transportation faculty in such institutions to UMTA research programs. Faculty at minority institutions have a number of institutional constraints that hinder full participation in research programs. The workshop was designed to help faculty deal with those constraints and also approach the complexities of grant and contract research. A rigorous selection process culminated in the choice of 15 participants in 1980 and 12 in 1981. The majority of the participants were from historically black colleges. Seven weeks of the workshop were spent in carrying out the various phases of a research project—from a grant application through a final report. One week of the workshop was held in New York City, where the participants had extensive lectures on and tours of New York's complex transit system. The success of the workshop was measured by both postworkshop evaluation and the continuing transportation work of the participants. The workshop was influential in the establishment of a new working network.

In September 1979, the Office of Policy Research of UMTA issued an invitation for applications to host a workshop in research skills for minority institution faculty. This workshop, a precedent-setting example on the training of research skills in urban transportation problems, was consistent with the policies of the U.S. Department of Transportation and the department's attempt to ensure that faculty from minority institutions were fully involved in its overall research and development effort.

For a number of reasons faculty from minority institutions had a low level of participation in urban transportation research.

1. Minority faculty have interest, but lack technical expertise, in specific research program issues;
2. A critical mass is often lacking at a minority institution, so that full capability in a particular subject area (e.g., fare policy, paratransit, and planning methodology) cannot be developed;
3. U.S. Department of Transportation programs are perceived as highly technical and engineering oriented; however, faculty talents may not lie in engineering or the sciences;
4. Minority institution faculty are not part of an old buddy network and faculty find entry level access to the state of the art in the problem area difficult;
5. Minority institutions are often overshadowed by other institutions in their region and find cooperation with these institutions, or local or state connections made by these institutions, difficult;
6. The time available for faculty at many minority institutions to devote to research is small and resources available to conduct research at larger institutions (e.g., fully stocked libraries) may not be available or sufficient; and
7. Many minority institutions have not developed the administrative capability to conduct research programs.

In response to the UMTA invitation, an application to hold the 1980 UMTA Summer Faculty Workshop for Minority Institution Faculty was submitted by a team representing two universities within New York State. This team, The Center for Transportation Studies and Research of the State University of New York (SUNY) located at Buffalo, and the Transportation Training and Research Center of the Polytechnic Institute of New York (PINY), designed a workshop that would have two major objectives:

1. To involve the participants in a meaningful, practical, applied research project dealing with one or more significant, but appropriately scaled, urban transportation issues; and
2. To develop in the participants research management skills that will make them better able to cope with constraints at their institutions that detract from the conduct of research.

To meet these objectives, the workshop was designed to immerse the participants in eight weeks of transportation analysis, research, and learning, with emphasis on research into current, topical urban transportation issues. This eight-week term would have two components:

Phase 1--Conduct an intense research program at SUNY at Buffalo for seven weeks and
Phase 2--Study the complexities of a major urban transportation system, that of New York City, carried out at PINY in Brooklyn, N.Y.

To meet the objectives of the workshop, the overall project effort was organized into three phases:

1. Workshop preparation,
2. Conduct of the workshop, and
3. Workshop evaluation.

WORKSHOP PREPARATION

Because of the short lead time, a number of tasks had to be accomplished during the first few months of the project. These included

1. Preparation and mailing of workshop announcements to the widest possible audience,
2. Development of criteria for selecting the participants from among the applicants,
3. Selection and notification of participants,
4. Development of the daily schedule for the workshop, and
5. Preparation of the sites.

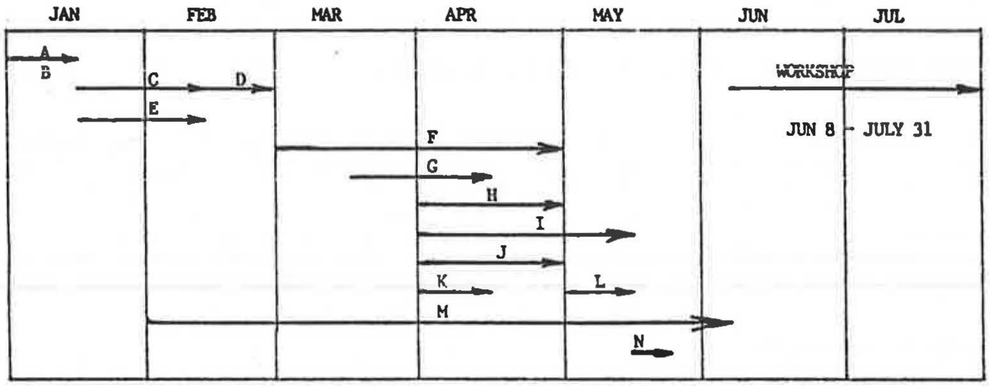
A timetable for the project is shown in Figure 1.

The two most critical concerns that had to be addressed in the preparation phases of the workshop were the selection of 15 participants who would most likely be motivated to respond to UMTA's research and development programs and the design of a program to meet the overall objectives of the workshop. The number of participants was based on maximum support available for the participants from UMTA.

Selection of Participants

A comprehensive set of names was developed to which announcements would be mailed. This set included representatives from historically black colleges, womens' colleges, colleges that have a high percentage of Spanish-speaking students, and colleges that have a high percentage of native-born Americans. However, specific faculty who would most likely respond could not be identified unless they had participated in a previous U.S. Department of Transportation program. Thus, mailings went to administrators, pertinent department heads, and some faculty. The workshop was not designed for administrators but for young faculty members. Thus an

Figure 1. Schedule of workshop preparation.



A. Review of the workshop agenda
B. Review of the workshop preparation timetable
C. Update set of institutions and individuals for notification of workshop
D. Review of criteria for selection of participants
E. Preparation and distribution of program announcement
F. Development of detailed (day-to-day) agenda
G. Development of research problem statements
H. Compilation of conference resource material
I. Confirmation of workshop staff appointments
J. Selection of participants
K. Survey of participants
L. Simultaneous to the tasks above: site preparation
M. Final printing of agenda and resource material
N. Mailing resource and site information to participants

announcement and accompanying letter stated explicitly that administrators should convey the nature of the workshop to the appropriate faculty. Telephone follow-up and discussions with faculty at these institutions revealed that this was not always done. This is a major problem that has yet to be solved. However, by using the participants and applicants as the start of a network, we believe this problem can be overcome within a few years.

The applicants represented a wide range of disciplines and research and transportation experiences. This is shown in Figure 2. Applications came predominantly from the Southern and mid-Southwestern schools, which is a reflection of the national distribution of minority institutions. The closing date was indicated as March 15; however, 75 percent of the applications arrived after that date. Requests for applications continued to arrive until early June.

The selection process had to be based on information submitted on the workshop application. In addition to personal information concerning the applicant and a brief essay by the applicant discussing why he or she wished to attend, a letter of commitment from an institution official to assist the faculty member in the conduct of transportation research was required. This was a necessary document, considered to be an important step in overcoming the institutional obstacles noted earlier. Although a personal interview was ideally necessary for the selection, funds were not available for such interviews.

The evaluation form for selection used these documents and established the following criteria for evaluation:

1. Interest,
2. Intellectual ability,
3. Academic credentials,
4. Experience, and
5. Institutional commitment.

Selection Teams

Three selection teams, each with a SUNY staff member, a PINY staff member, and an UMTA or other U.S. Department of Transportation official selected the 15 participants. Each of the applications was scored based on the preceding weighted criteria. The top 22 candidates were discussed by the committee of the whole to make a final selection. Table 1 gives the final selection. All selected agreed to participate in the workshop.

Thus, a mailing of more than 700 notices resulted in 40 applications and the selection of 15 participants. With greater effort to reach faculty and overcome administrative roadblocks, many more applications would be forthcoming.

Design of Program

The program was designed to lead the participants through every aspect of an urban transportation research project. This included

1. Introduction to application or proposal preparation and actual preparation of an application for a grant,
2. Development of a management program,
3. Gaining of familiarity with the literature,
4. Gathering of field data, and
5. Actual conduct of research, including the issuance of research, interim, and final reports.

The workshop was to be held at the Amherst Campus of SUNY at Buffalo, in a unique collegiate setting believed conducive to a major group work effort. Arrangements for housing and meals were made on the campus and designed so that the day could be structured around workshop activities. Program materials, schedules, and a notebook with a daily agenda for the eight weeks were prepared for distribution at the start of the workshop.

CONDUCT OF WORKSHOP

The primary objective of the 1980 summer workshop for faculty from minority institutions was to involve the faculty participants in UMTA's research programs. The intent of the workshop, therefore, was to expose the workshop participants to the full process involved in learning about obtaining, conducting, and reporting on contract research. The basic research experience of the participants was enriched through exposure to the problems and issues currently of concern to UMTA and to the public transportation field in general.

General Structure of Workshop

The workshop consisted of four component elements,

Figure 2. Profile of applicants and participants—1980 UMTA summer faculty workshop for minority institution faculty.

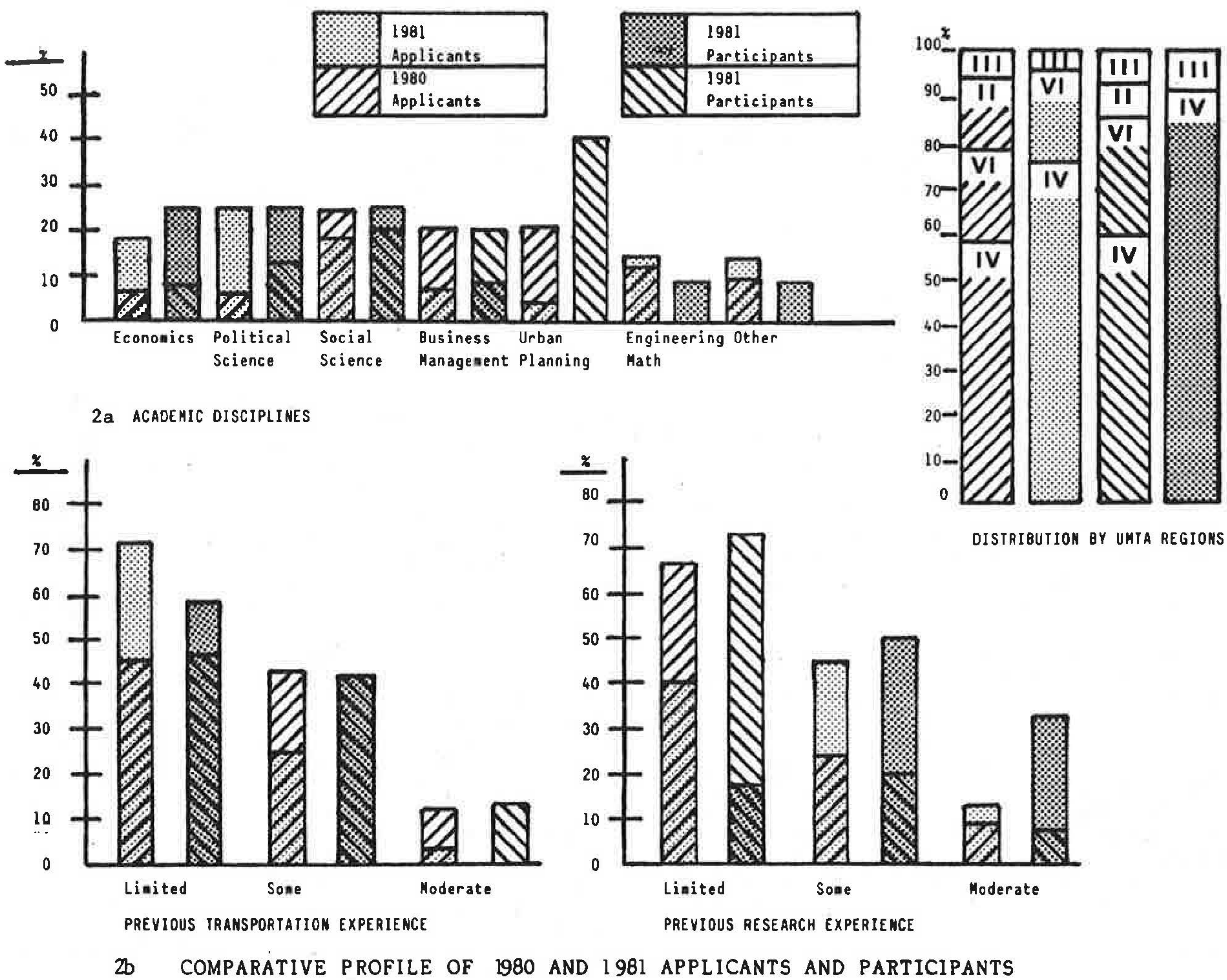


Table 1. Final selection of applicants.

1980			1981		
Institution	State	Discipline	Institution	State	Discipline
Alabama A&M University	Alabama	Planning	Albany State College	Georgia	Political Science
Bethune-Cookman College	Florida	Social Science	Atlanta University	Georgia	Marketing
Dillard University	Louisiana	Business	Benedict College	South Carolina	Economics
Elizabeth City University	North Carolina	Geography	Bethune-Cookman College	Florida	Sociology
Jackson State University	Mississippi	Economics	Coppin State College	Maryland	Sociology
Morris Brown College	Georgia	Education	Fayetteville State University	North Carolina	Math
New Mexico State University	New Mexico	Geography	Florida A&M University	Florida	Political Science
N.C. A&T State University	North Carolina	Business	Fort Valley State College	Georgia	Political Science
North Carolina University	North Carolina	Law	Fort Valley State College	Georgia	Sociology
Philander Smith College	Arkansas	Sociology	N.C. A&T State University	North Carolina	Business
Savannah State College	Georgia	Political Science	N.C. A&T State University	North Carolina	Engineering
St. Augustine's College	North Carolina	Business	Winston-Salem State University	North Carolina	Political Science
Texas Southern University	Texas	Urban Resources			
University of District of Columbia	District of Columbia	Urban Planning			
University of Puerto Rico	Puerto Rico	Planning			

Table 2. Agenda for summer minority institution faculty workshop.

Week	Morning	Afternoon
1	Introduction to transportation research problems; proposal preparation	Preparation of management plan; initial research
2	Research and site visits[a]	Research; quarterly letter report
3	Research and site visits[a]	Research; preparation of proper report
4	New York City	New York City; quarterly letter report
5	Research	Research
6	Research and site visits[a]	Research; quarterly letter report
7	Research	Research
8	Preparation of final reports	Presentation of final reports

[a] Site visits to be scheduled at appropriate times during conduct of research.

orchestrated in a cohesive fashion to provide for a total learning environment. Each of the elements contributes either to the provision of background information on techniques and problems in the transportation field or directly to the research experience. The four main elements are as follows:

1. A research problem capable of being solved within the time frame of the workshop (8 weeks), yet relevant and meaningful both in terms of the participants' experience and in terms of a potential problem solution;
2. Comprehensive on-site investigations of various transit facilities and agencies;
3. Special seminars on transit issues and problems (particularly those relevant to the research problem being investigated) by outside lecturers, transit operators, planning organizations, consultants, public officials, and others; and
4. Expository lectures concerning special skills that would be needed or potentially needed to address the research project.

The term of the workshop was eight weeks; seven weeks of which were conducted on the campus of SUNY at Buffalo, where the main activity was the performance of a research project and expository lectures as well as a limited number of on-site tours and seminars specific to the research problem being addressed. One week of the program took place in New York City, hosted by PINY. This week featured a variety of on-site tours of transit facilities. The New York City week exposed participants to New York City's large transit operations and planning activities, as well as to several special seminars conducted by various officials of the transit industry in the New York City region.

Workshop Staff

During the conduct of the workshop, particularly the 7-week period in which the research problem was executed, members of the project team were available on a continuous basis to workshop participants. This included the project director, Professor Paaswell and Professor Mulder of SUNY at Buffalo, and either Professor Falcocchio or Professor Roess of PINY. Also available at all times was Stephen Kirsch, a graduate assistant, who played a major part in the day-to-day organization of the workshop.

The workshop staff viewed its role as supportive, in terms of both substance and organization of the research effort. The intent, however, was to allow the workshop participants to address the research problem as they saw fit and to have a strong voice in the way they organized themselves for this effort. The organization of the research effort by the participants themselves was one major part of the research experience to which they were exposed.

Workshop Process

The workshop began on Monday morning, June 9, 1980, with a series of orientation lectures, presentations, and general discussion of what the workshop experience would entail. Each participant was given a workshop notebook containing descriptions of the project, tentative schedules, reference materials, and other general information useful to the participant in the workshop. As the workshop progressed additional material was distributed that could be placed in the looseleaf-style notebook. In this way, participants could compile a complete record of all activities.

Research Problem

The research problem selected for study was entitled, Capital Planning for Public Transit: A Case Study of the Decision Process. The Buffalo light rail transit system was used as a case study. Workshop participants were to investigate the planning process with respect to two key issues:

1. Were the general travel needs of the population well met by the system? and
2. Were the specific needs of minority groups well met by the system.

The intent was not to reexamine the particular decision made to implement a light rail system in Buffalo but rather to examine the process by which that decision was made and to identify how the needs of specific population groups and of the general public had been considered by that process. The end result was expected to be a series of recommendations for changes in the planning process itself, which would guarantee that such needs were not overlooked in the future. The topic was general enough for the workshop participants to exercise some free thought and novel approaches. Yet, a significant data base existed for the topic and a significant amount of information could be made available to the workshop participants, including access to sites and to planning and public officials who are involved in the decision-making process for the light rail system.

General Workshop Schedule

As part of the participants' workshop notebook, each participant was given a detailed schedule for anticipated progress throughout the 8-week period of the workshop (see general schedule, Table 2). This included a schedule of working sessions and due dates for various aspects of the material, as well as tentative schedules for lectures, seminars, site trips, and other aspects of the program. Obviously, during the course of the workshop, minor adjustments and changes were made on a daily basis to fine tune the progress being made by participants. Approximately 60 percent of the total 8-week period was devoted to working sessions; i.e., sessions in which the participants are directly involved in the conduct of the research problem or in presentations or discussions of their findings, progress, or results of that effort. The remaining time was divided among the other portions of the workshop program: lectures, seminars, and field trips of one kind or another.

The intent of the workshop was to expose the participants to the full range of the research activity--from the proposal or application for funding through the final report. The schedule also indicated the expectation of regular progress reports by the research groups.

Organization of Workshop Participants

A 15-member research team was considered unwieldly, partly because of the considerable breadth and variability of academic backgrounds and experience of the participants. For the initial effort in the writing of grant applications, five groups of three persons each were formed. For the research effort itself the workshop group was divided into three teams of five persons each. The groups were established by members of the workshop staff based on an evaluation of the academic backgrounds and experience of the participants. This was done with the intention of providing, insofar as was possible, teams with a balance of both different academic backgrounds and actual research experience.

Three-member teams were deemed appropriate for the application for funding process, as this was to be a relatively brief document prepared in a short period of time. Working groups larger than three would have been difficult under these circumstances. The research effort itself was a more substantial effort and larger working groups were judged to be more workable in this setting. Each of the three research groups elected its own group leader, and a project director was selected from among the three initial group leaders. Later in the process the project director came to believe that he should not double as a group leader, and that person's group selected another individual to serve that function.

The three research groups did not work in parallel. Each group studied and reported on particular aspects of the problem. The project final report was the sum total of the three groups' efforts. An alternative to this organization would have been to allow each research group to independently produce an entire project report and have all three groups essentially working in parallel on the total problem. In retrospect this latter idea may have been more effective, as the coordination of 15 individuals toward a single product was often difficult and consumed an inordinate amount of time.

The workshop effort began with each of five application groups preparing an application in response to a standard-format UMTA invitation to submit. Each group submitted a written application and presented it orally before the full workshop. The workshop staff evaluated each application, selected a winner, and used it as the basis for an overall group work plan, which formed the basis for the actual conduct of research.

Salient points from other applications were added to the winning application. The group was then assembled to establish working tasks and schedules and the research tasks were divided among the three research groups. This process turned out to be a most difficult one, and almost as much time was spent discussing how the various groups would interact with one another as was spent actually discussing the research project.

To assist the workshop participants in the conduct of their research, the workshop notebook was also distributed. The notebook provided hints on how to conduct the various tasks involved in the research, from literature reviews through the formulation of recommendations.

Reporting and Monitoring

Each group was required to report weekly on its progress. The reports were given orally before all three groups, the workshop faculty, and staff. Reports followed a prescribed format and focused on the kind of progress made and difficulties encountered rather than on technical detail.

Periodic interim reports of greater detail were also required. These were also delivered orally to all participants, the faculty, and staff. The interim reports focused more on substantive findings and progress during the particular reporting period. Often the interim reports were accompanied by detailed write-ups of a particular task, which were reviewed in detail by the workshop faculty and staff and then returned to participants with specific comments. The reporting process was found to be most useful, although the specifics involved in the organization of interim reports, weekly reports, and other discussion forms were at times time-consuming. The constant interchange of ideas, thoughts, problems, and progress among the participants themselves, between and among the research groups, and between the workshop faculty and staff and the participants made for a rich working environment and resulted in a more meaningful end result.

Lectures, Guest Speakers, and Field Trips

The research project was the focus of the workshop; however, the workshop incorporated a number of other aspects that supported the total learning experience. These included special lectures, seminars, and various field studies.

In general these served a dual purpose:

1. Exposure of workshop participants to a wide variety of transit-oriented problems, agencies, and operations to impart a better understanding of the field in which they are expected to do future research; and
2. Exposure of workshop participants to the subject of their research project (i.e., the case study involving the Buffalo light rail rapid transit system).

During the 7 weeks of the course at the SUNY Buffalo campus the program consisted of a number of special lectures given by members of the workshop faculty and a number of seminars given by various officials of local, state, and federal transportation agencies, many of whom had been directly involved in the decision to implement the light rail transit system in Buffalo. During the 7-week Buffalo portion of the workshop, participants also went on a number of field trips to local planning agencies and to various sites along the route of the light rail transit system now under construction.

These lectures, seminars, and field trips were scattered throughout the 7-week Buffalo program to achieve maximum benefit to the participants. The seminars were scheduled to impart particular pieces of information at a time when they would be most useful to the conduct of the research project. These other activities were also used to help break up the tension of the torrid pace of work required to complete the research effort within the 7-week time frame.

Participants were brought to New York City on Sunday, July 6th for a week of tours, field trips, and special seminars. These included tours of a New York City Transit Museum, the Coney Island Rail Rapid Transit maintenance facilities (the largest such facilities in the world), a bus maintenance and dispatching facility, rail and bus control center operations, and the main offices of the New York City Transit Authority and the Metropolitan Transit Authority. Special lectures included those given by several high-ranking officials in a number of metropolitan-area transportation agencies. The week proved to be a most useful experience and provided the broad exposure that had been planned.

WORKSHOP EVALUATION

A number of evaluations of the workshop were carried out. These included

1. A midworkshop and final assessment by the participants,
2. A New York City trip assessment by the participants,
3. A postworkshop follow-up assessment by the participants, and
4. An evaluation of the workshop by the staff.

Participant Evaluation

Participants were interviewed to obtain information about their expectations for the workshop and reactions to the organization and process of the workshop. The interviews were started toward the end of the second week and continued through the fourth week. Four sets of open-ended questions were asked:

1. Were the purposes of the workshop clearly stated in the announcement brochure? What did you believe those purposes to be? What were your own reasons for applying to attend the workshop?
2. Are there any significant differences in your present perceptions of the workshop's purposes as compared with your preworkshop perceptions? How compatible are your own purposes for attending the workshop with its purposes as you perceive them now?
3. What is your opinion about the workshop process as selected to its organization and structure? How do you feel about the workshop in terms of the interactions of the participants with one another?
4. Do you have any suggestions for modifications or changes in relation to the workshop's format or process?

Four structured questions were asked to assess what the participants thought about the progress of the workshop:

1. How do you feel about the attainment of your own, personal objectives for the workshop so far?
2. How do you feel about the attainment of the workshop's objectives so far?
3. How do you feel about your own interactions with other participants at the workshop?
4. How do you feel about the participants' interactions as a group?

The structured responses that the participants could make were very positive, positive, neutral, negative, or very negative.

About 2 months after completion of the workshop all but two of the participants were interviewed by telephone. The interviewees were asked to give their general reactions to the workshop and to indicate whether their perceptions had changed since the end of the workshop. They were also asked what transportation research activities they had undertaken or were planning to initiate. Finally, they were asked for any suggestions for future workshops.

The reaction of the participants was generally quite favorable. They were particularly impressed with the preparation that preceded the workshop and with its overall organization. Nearly all indicated that they were achieving their goals and that they thought the workshop was worthwhile. The participants had difficulties with the group dynamics processes related to timely completion of the workshop tasks. Specifically, problems existed in resolving conflicting interpretations and ideas about the tasks. However, the tasks were completed on schedule and were carried out competently.

The results of the interviews suggest that future workshops can be strengthened in three ways. First, additional emphasis can be placed on structuring expectations to increase clarity about the workshop's purposes and conditions. Second, group leadership roles can be defined more strongly and earlier to facilitate participant task interactions. And, third, the instructional format of the workshop can include a more structured lecture-seminar format in the early stages of the training. Modest changes in these three areas can provide significant additional benefits to the participants as follows.

Although participants were on the whole quite well informed about the workshop's purposes, and they considered themselves as such, the interviews showed that their expectations differed in some important respects. The main differences among participants' expectations pertain to the degree of emphasis they thought would be placed on substantive transportation problems versus research methodologies and techniques. They tended to be surprised about the diversity in backgrounds among themselves and, therefore, did not consider that a broad, balanced content would be presented.

Some participants thought that a background in transportation would be assumed so that the workshop would cover more advanced research techniques. Others expected that research knowledge was assumed, and that more emphasis would be placed on solving substantive transportation problems. The participants' comments make clear that the content of the workshop was well-balanced, but that participants' perceptions should be modified to expect a varied group of individuals who have different backgrounds and needs. This point can be addressed in informational brochures and at the start of the workshop.

A seemingly minor issue that, nevertheless, had a measurable impact on participants' perceptions concerns the workshop's facilities and amenities. Participants were informed that they would be staying in college dormitory facilities and that they had the option to obtain other accomodations. However, the relevance of this information was forgotten or did not register as important until several weeks had passed. As the demands of the workshop tasks increased, the lack of amenities in the dormitory setting became more frustrating. Perhaps if the participants would be made aware of the drawbacks of the facilities as compared with the life-style they were accustomed to, they could be more accepting or choose to stay elsewhere.

The first day of the workshop the faculty informed the participants that they were free to establish their own leadership roles within the task organization of three research teams and a project director. The development of a leadership structure proved to be considerably more difficult than anticipated and hampered the smooth functioning of the work groups. A large amount of time was devoted to the resolution of conflicts, which frequently involved relatively minor issues. The group was able to overcome the resulting difficulties in group dynamics, but at a certain cost in frustration and time. More structured leadership functions may be useful at a future workshop to find out if the group process will improve.

A number of participants indicated that they benefited from the speakers and lectures. Several expressed some regret that certain lectures were not scheduled earlier in the training so that they could better apply their learning in the research tasks they were carrying out. The interviews indicate a consensus that a fuller and more rigorous schedule of lectures in the first 2 or 3 weeks of training would be more beneficial. It was also pointed out that the speakers as well as the participants should

Figure 3. Final analysis of workshop by participants.

	YES	NO	UNDECIDED
Do you intend to pursue research in trans.	12		1
Do you intend to apply for support	12		1
To UMTA	12		1
To RSPA	7	5	1
Other DOT Administration	6	6	1
Other	6	6	1
Do you intend to contact other participants in the workshop with respect to the discussion of research ideas?	12	1	
To participate in research projects	9	3	1

Most Rewarding Experience from the Workshop

1. Contacts
2. Exposure to Transportation Research
3. Opportunity to work with colleagues with diverse background
4. UMTA Procedures
5. Working in a different region of the country

Least Rewarding Experience from the Workshop

1. Living conditions
2. Speakers
3. Time Constraint
4. Group Tasks
5. Lack of Counseling
6. Being away from family

make every effort to develop a professional seminar atmosphere.

The final series of follow-up interviews, conducted more than 1 month after completion of the workshop, showed that the faculty participants were satisfied with the workshop results. They thought that they had benefited significantly from the experience and that they would incorporate the material they had learned in their future work. Nearly all indicated that they had already started projects related to transportation research and had approached various individuals and organizations to express their interests in certain transportation problems. Figure 3 summarizes these findings. A large percentage of the workshop's participants seem to have been influenced to become active in transportation research.

Summary Evaluation

The workshop can be evaluated in a number of ways. An overall evaluation can be established by comparing the conduct of the workshop and the follow-up work of the participants with the expectations of the sponsor (UMTA), the staff (SUNY and PINY), and the participants.

Sponsor

UMTA's objectives were to have increased involvement of minority faculty in UMTA research and development programs. Although we recognized at the outset that some time would be needed to fully involve faculty who faced institutional constraints on their ability to generate research, we looked for some signs that such generation would be forthcoming. A number of results of the workshop indicate that this aspect, the generation of research, was a success.

UMTA received four applications for the FY 1981 invitation to submit to their university research program. An additional application was received, but it was too late. Three faculty members submitted proposals to the Research and Special Programs Administration (RSPA) of the university research program. More than half the participants have engaged in discussions with U.S. Department of Transportation personnel regarding research topics. Two of the participants are active in forming a transportation group in Atlanta, Georgia. They have also taken the lead in making contacts with local professionals. One of the participants has formed a transportation research group in the Southwest and is promoting a new transportation curriculum at his university. Some of the participants have begun to form, through correspondence and meetings, an informal but active network. One of the participants is pursuing transportation interests more actively than she anticipated and is seeking out others at her institution to collaborate with on research problems.

The actual conduct of research is a basic measure to the sponsoring office; however, other benefits also go to UMTA and to the U.S. Department of Transportation from the workshop. Several of the participants have contacted or now work with local planning or transit operating officials. This interaction and the sharing of capabilities at the local level is the basis of an indirect benefit to UMTA. The improvement of local expertise makes it easier for UMTA to deliver technical assistance.

The increased transportation knowledge, coupled with information on where information can be obtained, stimulates course development and student preparation. Minorities are underrepresented as professionals within the overall transportation industry. The opportunities and incentives to pursue such a career can be demonstrated to students through the enthusiasm and depth of knowledge of their professors. Further, the contact that their professors have with UMTA staff, on a personal basis, increases their credibility and respect within the classroom. Finally, the ability to work on funded research becomes a step in professional training.

Workshop Participants

The participants came with a heterogeneous set of objectives. Some wished to learn proposal writing, some to become familiar with transportation literature, and others to learn how to be successful researchers. Some were accomplished researchers; others had not conducted a literature search since their dissertation. This heterogeneity led to several group dynamics problems because the group could not agree on a unanimous set of objectives.

The midworkshop critique indicated a lost in the forest attitude. The participants were working hard and realized that they were learning and absorbing something, but they were not sure of the match between their expectations and what they were learning. The final critique showed that most (77 percent) thought that their expectations had been met and all would recommend it to others.

The postworkshop evaluation showed that concern about living accommodations was less important than indicated on the evaluations. A review of the most rewarding and least rewarding experiences showed that the most rewarding experiences all dealt with professional experience (e.g., contacts, knowledge of UMTA procedures, and transportation research); the least rewarding experiences concerned living conditions and group dynamics. Only in the choice of certain speakers did the group note any dissatisfaction with the workshop itself.

The current activities of the participants indicate the substance they had taken from the workshop. These underline an important point: Whatever their expectations before the workshop, the majority of participants believe incentives exist to conduct transportation research, regardless of institutional barriers, and have set about to do so.

Staff

The workshop staff had the challenge of bringing together UMTA objectives with participant expectations. Further, the staff had to ensure that the living accommodations were reasonably comfortable and did not get in the way of the conduct of the workshop itself. The most satisfying element of the workshop to the staff was the total involvement the participants gave to every aspect of the workshop. The development and production of a comprehensive final report, on schedule, characterized the overall sense of the workshop.

The staff found that their roles were clearly delineated. However, one aspect of the workshop, the group dynamics problems, were not anticipated. Workshop staff often had to resolve small issues. When possible the issues were classified, or restated, and given back to the participants to resolve. The issues were mainly definitional and never arose from an unwillingness to assume a responsibility of workload.

One of the objectives of the staff was to ensure that adequate transportation information would be available throughout the workshop. The presence of four staff at all times plus a major resource room and guest speakers made it possible for the participants to conduct their work with a minimum amount of hunting for information. A secretary was also made available to the participants and staff for the entire workshop. These last two factors are not real-world conditions. Few research groups at any institution have all resources at their fingertips.

One of the staff objectives was to develop self-confidence in the participants so they could be effective lobbyists for their research. A finding was that the development of self-confidence was not an issue. The workshop group, talented and aggressive, needed to become familiar with the process of lobbying, the contacts to make, and the subject matter. The greatest hindrance to the development of research programs at minority institutions (based on the performance of the participants) was the institutional barriers created at their own colleges. There barriers include

1. Poorly defined chains of command--lack of responsibility for research assignments, contract negotiation, or contract sign-off;
2. Rigorous teaching schedule--no release time for research and inadequate support time; and
3. Lack of commitment of institution administration to academic research.

Again, the single most visable product of the workshop was the proposals and applications submitted to RSPA and UMTA. More important, however, was the intangible product, the active network of transportation activities started by the workshop graduates.

1981 WORKSHOP

Based on the measures of success identified previously UMTA entered into a cooperative agreement with the same team of academic institutions to conduct a workshop during the summer of 1981. Although the aspects of preparation were the same, the format of the 8 weeks changed slightly. A research problem was designed to be completed in 6 weeks. One week was spent in extensive field trips and lectures in New York City. The participants spent the final week developing initial applications and proposals to the U.S. Department of Transportation for the conduct of a research project.

Twelve faculty from historically black colleges were selected for this workshop. Because of the late date at which U.S. Department of Transportation university solicitations have been issued, it is not possible at the time this paper was written (November 1981) to know the extent of participation of the group in U.S. Department of Transportation programs.

ACKNOWLEDGMENT

The work was carried out under a cooperative agreement with UMTA. Much of the success of the workshop was due to the strong participation of the advisory board. This included Philip Hughes (UMTA), Reginald Diamond (UMTA), Wilber Williams (RSPA), all of U.S. DOT., and William Lobbins of SUNY at Buffalo. In addition, the staff included James Mulder, Stephen Kirsch, and Eileen Hughes of SUNY at Buffalo. The five coauthors served on the advisory board. Nathaniel Jasper was the UMTA project monitor. Jim Mulder conducted much of the evaluation. The great success of the workshop occurred because of the tireless effort, enthusiasm, intelligence, and good

humor of 27 talented faculty members--the participants. They were: M. Alexander, G. Bowser, K. Cook, E. Davis, I. Glover, C. Jones, C. Jordan, E. Leung, D. Lyons, H. Ortiz, W. Porter, C. Smith, J. Smith, R. Sheck, H. Walton, K. Ankrah, M. Blount, D. Chase, C. Claiborne, K. Dorsett, L. Fitzgerald, C. Harvey, O. Jones, R. Krajick, S. Mahdi, J. Moore, and R. Ward.

Reentry of Women into the Transportation Profession: Program and Potential

ROGER P. ROESS, PAMELA E. KRAMER, AND LOUIS J. PIGNATARO

A National Science Foundation Women in Science program for the retraining of women seeking to reenter the job market in the transportation profession is described and discussed. The suitability of transportation as a reentry field is argued, and reentry students are shown to be a potentially large market of new students for graduate transportation programs.

The transportation profession is unique among the technical disciplines in that it can be entered at the graduate level by those who do not have an extensive technological undergraduate background. Many universities admit students to master's and doctoral programs in transportation without requiring undergraduate engineering degrees; however, sufficient background in mathematics is generally required. The multidisciplinary nature of the transportation profession and the high visibility of transportation to the general public make it an ideal field for college-educated men and women who are underemployed or who have become disillusioned with their original specialties, and who would like to enter a technical profession for the first time.

The term reentry has generally been used to describe women who, after an absence of years from the job market, seek to reenter the job market, often in a career substantially different from the one for which they were originally trained. During the 1960s and early 1970s women were most often encouraged to study education, humanities, social sciences, and other nontechnical subjects. A large number of these women are now unemployed or underemployed, yet well-educated adults, trained in fields for which the job market is declining.

Under the sponsorship of the National Science Foundation Women in Science program, Polytechnic developed and implemented a unique program for the retraining of college-educated women in the transportation profession. The program was initiated in January 1981 and continued through June 1982. The program demonstrated (a) the ability of many women to quickly adapt to a technical profession and (b) such women represent a substantial student market potential.

PROGRAM

The special program designed for reentry women had two primary emphases:

1. Remediation and reorientation to the transportation profession, and
2. Earning graduate credits toward the M.S. degree in transportation planning and engineering.

As most of the program participants would have nontechnical backgrounds, mathematics remediation was a principal concern. All participants, with the exception of a few who had significant mathematics background, took a remedial mathematics course during their first semester, which was Spring 1981. The course, which met for 4 hr/week over a 20-week period, covered what is traditionally referred to as precalculus (i.e., advanced algebra, analytic geometry, and some trigonometry). This was followed by an applied statistics offering during the Summer 1981 session. During this period, all participants took an introductory transportation course for which they received graduate credit.

During the first semester program participants took all courses together, partly to foster group coherence, and partly to avoid causing early frustrations by placing participants in mixed class sections. During the 1981/82 academic year, however, participants attended regular graduate sections with other students.

The three-semester program also included a number of special seminars and short courses, including

1. Career day--An all-day conference and seminar attended by prominent transportation professionals in the New York City metropolitan area to expose participants to the breadth of opportunities in the profession;
2. Planning approach to problem-solving--A seminar discussion of the technical planning approach to solving transportation problems; a discussion of quantitative versus qualitative analysis;
3. Technical writing--A seminar on technical writing and the preparation of technical presentations, including the use of graphics and displays and public speaking; and
4. Resume writing and job search--A full-day workshop on preparation of technical resumes and on job search and interview techniques.

In addition to these special programs, regular bimonthly meetings were held to discuss any problems that participants might be encountering either with the program or with interactions with faculty, other students, or among themselves. Early in the program some intragroup conflicts arose over the remedial mathematics course--some thought it was too advanced, others, too elementary. As the program progressed, however, few such problems arose.

Thoughout the program, participants had available special guidance and counseling from the Polytechnic's women's programs office. This office provided a good deal of assistance to participants in adjusting to a technical education and in becoming an active part of the general student body.

The general structure of the three-semester program is summarized in Table 1. Its intent was to gradually introduce participants into the mainstream of the profession and of university life, an objective that was achieved with reasonable success.

Table 1. Outline of program content.

Term	Courses and Seminars	Credits
Spring 1981	Remedial mathematics (precalculus)	0
	Transportation studies and characteristics	3
	Career Day seminar	0
	Planning approach to problem-solving seminar	0
Summer 1981	Applied statistics	3
Fall 1981	Regular graduate courses	9
	Research writing and job seminar	0
	Waterborne transportation seminar	0
Spring 1982	Regular graduate courses	9
	Technical writing seminar	0
Total		24

Note: Twenty-one of the credits were applicable to the M.S. degree.

Figure 1. Advertisement placed in New York Times.

Table 2. Distribution of participant backgrounds.

Item	Response	Number
Highest degree earned	Bachelor of arts	19
	Bachelor of science	4
	Bachelor of business administration	1
	Master of arts	4
	Master of science	8
Ethnicity	Black	9
	Hispanic	1
	Caucasian	26
Age	20-30 years	16
	31-40 years	17
	41-50 years	2
	51 or more years	1
Marital status	Married	16
	Single	19
Children	0	20
	1	4
	2	6
	3 or more	5

PARTICIPANTS

Participants were sought through a limited advertising campaign, the cornerstone of which was an advertisement placed in the New York Times. The ad, shown in Figure 1, was run three times--in Tuesday's education section (October 14, 1980), Wednesday's home section (October 22, 1980), and Sunday's employment section (October 5, 1980). These placements offered exposure to the maximum audience at reasonable cost. The ads were supplemented by a press release that appeared in several local newspapers and women's publications.

The response to the program was astounding. More than 900 requests for information were received. Each respondent was sent two brochures that describe the program and an application. These requests resulted in 138 applications for the 40 available program slots. Of these, approximately half were eliminated after a review of transcripts; most would have required more extensive remediation than was available through the program. Approximately 70 applicants were interviewed, and final selections were made. Forty-four applicants were accepted into the program, with 8 declining. The program was initiated in Spring 1981 with 36 participants.

The characterization of a typical participant is difficult; they ranged considerably in background. Nevertheless, the average participant could best be described as caucasian, about 30 years of age, single with no children, and having an undergraduate degree in education. Table 2 details the distribution of participant backgrounds.

The response to the program reflects several key factors:

1. Substantial numbers of women remain underemployed;
2. Many such women are anxious to seek new careers, often radically different from the careers for which they were originally educated; and
3. Substantial numbers of women are seeking to reenter the job market, even where families include several children.

The economic realities of the day dictate that more and more women enter, reenter, and remain in the professional work force. This, coupled with the relatively poor employment picture for those in education, or who have general liberal arts degrees, presents a challenge and an opportunity to the transportation and other professions. Note that most of the women who were interviewed, and doubtless most who sought information, had little understanding of what the transportation profession entailed. The ease with which most participants immersed themselves in the field was truly astounding and a testimony to the dedication of reentry students--a dedication that often exceeded that of other students in the Polytechnic's transportation program.

Performance

Of the 36 women who originally enrolled in the program, 24 completed it in June 1982 and received graduate certificates. The result, a two-thirds retention rate, is considered good, compared with an approximately 50 percent rate in other NSF Women in Science programs across the nation. Note that of the 12 dropouts only 5 were due to an inability to understand course material. Others dropped out for a variety of reasons, ranging from health problems to promotions or achievements in their current professions. Three simply decided they were not suf-

Table 3. Analysis of grades.

Course	Character of Course	A	B	C	F	INC/W
MA005 Remedial math	Math	2	8	4	2	7
MA551 Applied statistics	Math	19	5	2	0	1
Subtotal		21	13	6	2	8
TR 600 Transportation studies and characteristics	Descriptive	13	7	7	0	1
TR 630 Urban planning	Descriptive	9	4	0	0	2
TR 661 Intercity passenger and freight transportation	Descriptive	2	0	0	0	0
TR 751 Transportation finance	Descriptive	2	3	0	0	0
TR 756 Sociological aspects of transportation	Descriptive	1	1	0	0	1
TR 757 Transportation management	Descriptive	1	1	0	0	0
TR 758 Transportation policy and decision making	Descriptive	3	0	0	0	0
Subtotal		31	16	7	0	4
TR 601 Travel demand forecasting	Analytic	0	5	6	0	1
TR 602 Urban transportation planning	Analytic	1	0	0	0	3
TR 603 Computers in traffic and transportation planning	Analytic	1	1	2	0	0
TR 660 Urban public transportation	Analytic	5	2	0	0	2
TR 701 Traffic operations, control, and management	Analytic	14	3	0	0	1
TR 703 Traffic studies	Analytic	5	5	1	0	1
TR 704 Traffic capacity	Analytic	5	1	2	0	1
TR 750 Transportation economics	Analytic	8	9	1	0	1
TR 845 Analytic techniques in transportation	Analytic	3	0	0	0	0
TR 865 Highway traffic safety	Analytic	3	0	0	0	0
Subtotal		44	26	12	0	10
TR 624 Transportation workshop	Design	6	2	0	0	0
TR 710 Design of traffic facilities	Design	0	0	1	0	2
TR 715 Urban goods movement	Design	1	1	0	0	3
TR 670 Design of terminals	Design	3	1	0	0	1
TR 671 Airport planning and design	Design	1	3	0	0	1
Subtotal		11	7	1	0	7
Total		107	62	26	2	29
Percentage of total for participants		47.3	27.4	11.6	0.9	12.8
Percentage of total for all students		49.1	27.3	10.8	5.0	7.8

ficiently interested in transportation to pursue a career in it.

Table 3 summarizes the grades received by program participants. Courses are grouped into four principal categories based on their content:

1. Courses in basic mathematics,
2. Transportation courses primarily descriptive in content,
3. Transportation courses primarily analytic in content, and
4. Transportation courses that have heavy design content.

Despite the nonanalytic, nontechnical backgrounds of most of the participants, their academic performance was extremely good across-the-board. Though they did slightly better in descriptive courses, they had little difficulty in handling the transportation curriculum and performed well in analytic and design courses. When the grades of participants are compared with those of the entire student body enrolled in transportation programs, there is no significant difference in their performance. Program participants failed courses at a much lower rate than did the general student body but compiled more incomplete grades. The percentage of participants who passed courses and the distribution of passing grades is virtually the same as for the general student body.

The lowest grades were achieved in the remedial mathematics course. Several factors contributed to this:

1. This was the first course in the program,
2. The course was intensive and covered much material in a relatively short time-frame,
3. Math anxiety among participants was high and lessened only with time as confidence was built,
4. The instructor was not as responsive to the particular needs of the participants as he might have been, and
5. The course contained many of the participants who later became dropouts.

Interestingly, grades in the applied statistics course, which followed the remedial math offering, were considerably better. A slower pace, reduced math anxiety, and a change in instructors probably contributed heavily to this improvement.

Participants' reaction to a sudden reorientation to analytic learning was of some concern; therefore, attitudinal surveys were conducted during the first weeks of the program. These surveys evaluated a number of factors regarding individual participants' attitudes toward technical subjects in general, and math in particular. When these attitudinal factors were regressed against the math course grades of participants, the regression coefficient was an amazing 0.954. Those who were having difficulty in mathematics were having such difficulty primarily due to deep-seated negative feelings about their ability to learn math, not due to any basic problem of ability. One of the most gratifying aspects of the program was that many of these negative feelings were overcome by careful remediation and counseling.

Of the 24 women who completed the program, 5 were particularly outstanding. Additional support was found to enable these five to complete their master of science degrees in June 1982. For these five,

Table 4. Summary of survey evaluations.

Program Component	Average Rating
Initial orientation to transportation	3.9
Remedial math course	3.3
Statistics course	3.6
Tutoring, other academic support	3.6
Academic advising	4.0
Regular academic program and courses	4.3
Career counseling	2.9
Assistance with job placement	3.4
Faculty	4.3
Personal counseling	3.2
Overall program	3.8

Note: Ratings range from 1 (very dissatisfied) to 5 (very satisfied).

the full transition to a new profession was completed in only 18 months--a transition from a nontechnical profession to one in transportation planning and engineering.

Placement

Placement of participants is difficult to evaluate because the job market in the profession is soft at the present time due to the general state of the economy and shifts in federal transportation policy. Also, many of the participants were not going to seek employment until they completed their master of science degrees. For most this would be June 1983.

Nevertheless, at this writing, the following placements have occurred:

1. Two transportation planners at Vollman Associates,
2. One administrative planner at New Jersey Transit,
3. One transportation planner at Urbitran Associates,
4. Two engineering technicians at the New York City Department of Transportation, and
5. Two full-time fellowship appointments for continued study at Polytechnic.

In addition three participants are currently discussing possible positions with other employers, and one turned down a job offer for personal reasons.

The placement of participants was pursued actively; numerous on-campus visits and interviews were arranged. Clearly, the slow job market has kept placements below their anticipated levels. Indications, however, are that most participants who are seeking placement will find positions within the next few months.

Participant Survey

In July 1982 a survey was sent to all participants, including those who had dropped out of the program, to get their impressions of the program. Part of this questionnaire dealt with placement. Some key responses follow:

1. Of those who responded, all intend to complete at least M.S. degrees in transportation; and
2. About one-third of the respondents were not considering any return to school; two-thirds were considering returning for additional work in other areas; only one participant was considering transportation-related study at the time the program was advertised.

Table 4 presents participants' ratings of various aspects of the program, each rated from 1 (very dissatisfied) to 5 (very satisfied); recommendations for improvement included better job and career counseling and placement services, a more detailed course on statistics not held over the summer, a better treatment of technical writing and public speaking, more student-faculty interaction in seminar settings, and better tutoring services.

When asked to cite positive aspects of the program, most referred to the opportunity to return to school and the confidence gained by addressing a technical subject with success. Social interactions with other participants and the quality of faculty were also noted.

None of these results is startling. The biggest disappointment was expressed over career counseling and placement, which is to be expected given the current slow job market. None of the women who had dropped out returned the survey questionnaire, so there was no opportunity to examine the reasons for their departures.

The survey shows a generally high degree of satisfaction with the program. As more of the participants are placed, the level of uneasiness and misgivings expressed over placement will diminish. Next year a follow-up survey will again be conducted to begin to trace some of the longer-term impacts of the program on its participants.

CONCLUSIONS

The following conclusions are offered as a result of the Polytechnic experience.

1. A substantial market of potential students for transportation programs exists among women (and possibly men as well) seeking to reenter the job market in new professions.
2. The transportation profession is ideal for reentry at the graduate level because of its interdisciplinary nature and the limited extent of remediation required for students who have a nontechnical background.
3. Remedial programs, although not extensive, must be planned carefully to gradually orient reentry students to technical learning and to overcome math anxiety, particularly in women who have nonanalytic backgrounds.
4. Reentry students are capable of performing as well as more traditional students in transportation planning and engineering programs.
5. Some employers specifically seek transportation professionals who have engineering backgrounds; however, most display equal interest in reentry and traditional students.

A program related to the Women in Science reentry sequence is the recently initiated Transportation Management program at Polytechnic. Many of the women have expressed interest in this aspect of transportation and will pursue M.S. degrees in the new program. A management-oriented transportation program is even more amenable to reentry training than planning and engineering programs that are more analytic in content.

FUTURE EFFORTS

Several institute-sponsored efforts are underway at Polytechnic to attract reentry students to the transportation program. An institutewide policy is currently being formulated that will offer reentry students (male and female) tuition support. A program is already in place in transportation that offers tuition support to employees of city agencies.

The latter has attracted primarily college graduates who have general backgrounds who are underemployed (many as motormen, bus drivers, and other laborers) and who will seek promotion within their current agencies. Tuition support is critical for these students because New York City offers no reimbursement and their salaries are relatively low.

The institutewide policy will cover several graduate programs that are appropriate for reentry training. Although no final selection has been made, such areas as applied mathematics, environmental psychology, and computer science are being considered. A key factor here will be a tight definition of reentry student. The intent of tuition support is to attract new students, not subsidize those already attending at full tuition. The amount of tuition support is also being discussed, although one-third to one-half tuition remission is the approximate range being considered.

As graduate engineering enrollments decline nationwide, transportation and other engineering programs will have to seek new student markets. Reentry students, particularly women, are one such market that has been clearly identified and tapped at Polytechnic.

Design of Training Programs for Transit Middle-Managers

DAVID A. SCHRIER, ROGER P. ROESS, AND WILLIAM S. ALLISON

A management training program developed by Polytechnic Institute of New York that is based on specific transit system experience is reviewed in this paper. The program will now be given under the sponsorship of UMTA, under funding from Section 10 of the Urban Mass Transportation Act of 1964. The process of training program design based on need analysis and systematic organization diagnosis has great potential for improving the impact of training on transit system operations. Finally, the concept of teams of university faculty drawn from management, transportation engineering, and industrial engineering disciplines is explored. The maximum potential for helping transit systems to develop state-of-the-art management development and organizational development strategies tailor-made for each transit system is achieved by using this approach.

Initial conversations between representatives of the Transportation Training and Research Center at the Polytechnic Institute of New York and the New York City Transit Authority (NYCTA) during the summer of 1979 revealed a serious need for management training for approximately 450 middle-managers. Middle-managers include a wide range of second-level supervisors of line functions and administrative positions just below department head.

As in most mass transit systems, the predominant background of this group is limited to high school education and in-house training. Almost all of these middle-managers have risen through the ranks and began their careers as maintenance workers, conductors, motormen, and bus drivers. They lack the supervisory skills for the managerial roles they now play. Under the sponsorship of an Urban Mass Transit Administration University Research and Training Grant, Polytechnic undertook the development of a training program to specifically address these needs.

The primary objective of the training program was to improve the performance of middle-managers in addressing problems within the existing management structure of transit agencies. The intent of training was not to change the basic management format of an agency or operator but to optimize the middle-manager's performance within the existing structure, even where the structure may be imperfect or inefficient.

UNIVERSAL THEORY OF MANAGEMENT VERSUS SYSTEM-SPECIFIC TRAINING OF TRANSIT MANAGERS

Normally in the transit industry promotion is based on performance on the job. University degrees are rare for middle-managers, who are predominantly action-oriented people. Outside of technical areas, the training departments in transit systems have given in-house courses that are based on the concept of the universality of management thought. Within this area of training, generally referred to as management development, the concept of universality assumes the usefulness of educating managers in the key functions of the management process:

1. Planning,
2. Organizing,
3. Directing,
4. Staffing, and
5. Controlling.

Universality within management thought assumes that management is a science based on principles for the five key functions of management listed previously. These principles are guidelines for all managers in all industries, for all hierarchical levels, and apply across cultural borders.

Considerable dissatisfaction is heard from line transit managers in the evaluation of traditional courses that are based on the universal concept. "All the cases we studied were based on how to get towels cleaned in the housekeeping department of Holiday Inns. The course was a waste of my time..." is a typical remark from a New York area transit manager.

Polytechnic's course attempts to avoid abstraction of thought and aims for the practical transfer of course learning to the job. The course avoids the broad category of education in the general or universal theory of management and is targeted at system-specific training based exclusively on cases and examples drawn from the shop floors of transit systems. This was the central idea for the design of the training program.

DESIGN PROCESS

The point of departure for the program design was the development and use of a need analysis questionnaire. Approximately 330 questionnaires were sent to NYCTA personnel who have the following job titles: supervisors, chief surface line dispatchers, assistant superintendents, and superintendents. The tabulated results formed the empirical base for the design of the training program. The goal of this participative process is that the pro-

Table 1. Results of curriculum design survey.

Topic	Include	Omit	No Opinion	Emphasize Topic
TA organization, role and responsibility of TA manager	183	7	17	54
Work planning	189	9	9	75
Written and oral communication	198	5	4	101
Interpersonal relations	183	8	15	65
Group dynamics	144	29	34	29
Motivating subordinates	186	11	10	105
Management rights and responsibility under union contract	189	10	8	73
Art of negotiation	124	44	37	31
Budgeting	116	48	43	18
Financial management and analysis	110	56	41	10
Management information systems	170	10	27	37
Inventory control	121	42	37	13
Ridership development	105	45	57	24
Measuring and improving productivity	188	8	10	94
Role of government in transit operations	132	34	41	14

Table 2. Outline of course curriculum.

Day	Time	Course
1	Morning	Conceptual overview of work planning and control
	Afternoon	Case studies in human relations—employee counseling, maintaining morale, and motivating employees
2	Morning	Case studies in work planning and control—rail rapid transit and surface transit
	Afternoon	Case studies in human relations—maintenance schedules and employee disputes
3	Morning	Case studies in work planning and control—group discussions
	Afternoon	Case studies in human relations—evaluating managerial performance and insubordination
4	Morning	Case studies in work planning and control—group discussions and wrap-up
	Afternoon	Case studies in labor relations—inspection procedures
5	Morning	Budgeting and management information systems
	Afternoon	Case studies in labor relations—disciplinary procedures
6	Morning	Conceptual introduction to productivity analysis
	Afternoon	Case studies in labor relations—sick leave disputes, overtime disputes, and holiday disputes
7	Morning	Case studies in productivity—current efforts at NYCTA
	Afternoon	Case studies in labor relations—grievance procedures
8	Morning	Inventory control—NYCTA VISTA system
	Afternoon	Mock grievance hearing—reassigning signal maintainers
9	Morning	Group analysis of current system problems in mass transit
	Afternoon	Mock labor negotiations
10	Morning	Relating to higher levels of management
	Afternoon	Final examination and course evaluation

gram design be based on the perceived needs of managers in the system. The curriculum was developed from the results of the survey, which are summarized in Table 1, and led to the curriculum outline given in Table 2.

Following the design of the curriculum, the course instructors began extensive on-site research in the NYCTA. The instructors developed their cases by interviewing and observing managers at work. Cases were developed from real transit examples, documented by using NYCTA files, records, and case histories.

ASSUMPTIONS AND GUIDELINES FOR TRAINING DESIGN

Interviews with managers from top to middle levels reflected a great deal of controversy regarding the development of materials. Chief fears included the following assumptions by management.

1. Traning for bus personnel would not be helpful to subway people, their jobs are too different.
2. This will be another textbook university course that is useless for practical application.
3. Operations people perceive that all training leads to more paperwork.
4. What good does training do? My boss will not let me try anything new.
5. Basically there are three types of transit managers: bus, subway, and administrative. What is useful to one is not useful to another.
6. Administrative people do not understand the lives of operating managers; the program needs some key top managers who came up through the ranks and are operating people's heros.
7. On the question of curriculum for work planning, there are no goals, no schedules, and no planning here.
8. The immediate need is for management tools to ease the current bottlenecks.
9. This program has to give the middle-manager a product, something in hand to use, a useful cookbook plan to follow.
10. If the course is general enough to reach across all levels, then it will not be specific enough to meet practical operating needs.
11. Finally, and perhaps most important, transit managers do not like to think, read, or write.

These comments are paraphrased quotes from the many interviews conducted among transit middle-managers in developing the curriculum. They highlight the general mistrust of typical training to which they are normally exposed, but for which they find little practical use.

The following guidelines, taking the above reality into account, became the operative standards for program design. Mixed classes of administrative, bus, and subway personnel are acceptable, even desirable; however, each course must be specialized by function. Maintenance and transportation are the two major functional categories for which separate training classes would be conducted. Within each function separate cases should be developed for subway and bus personnel, except where problems and issues are generic in nature.

During each training class, separated by the main functions listed previously, three different cases would be used to form smaller groups to work on rail, bus, and administrative cases. Case presentations to the larger group would pull the three divisions together but not tie each tediously to an area not of immediate interest. All materials would avoid wordy and academic approaches. The materials will be taken directly from transit reality and explained by examples of each technique. The examples will be solved in small groups formed by interest area and the results of each small group's solution will be shared with the entire training group.

Classroom exercises will emphasize oral communication and discussion, backed up (as appropriate) by written summaries. Cases will emphasize making the best possible use of existing structures and procedures and how to cope with any shortcomings of those procedures. Classroom discussions of cases will lead to consensus opinions on potential solutions or proper actions to be taken by middle-managers. No right or wrong answers will be identified, though the merits and possible outcomes of proposed solutions will be fully explored. Representatives of NYCTA will be used selectively to present specific aspects of procedures or to act as a resource for group discussions.

Figure 1. Results of course evaluation survey.

1) This course met 11 my expectations
exceeded 12
fell below 1

2) Five topics most useful to participants in their jobs: work planning and control (16), labor-mgt. relations (16), disciplinary and grievance procedures (13), human resource mgt. (12), productivity (4).

3) Topics least useful to participants in their jobs: productivity (10), budgeting (8), inventory control (5),

4) Five topics best presented: labor-mgt. relations (15), work planning and control (13), disciplinary and grievance procedures (9), human resource mgt (6), inventory control (4).

5) Topics worst presented: Productivity (10), budgeting (5), work planning and control (3).

6) Rate instructors on a scale of 0-10:

Schrier	8.8
Allison	8.6
Falcocchio	6.3

7) The use of NYCTA specialists to present details of NYCTA practice was:

beneficial 21
not beneficial 1

8) Was the case study approach effective?

Yes 23
No 0

9) Did NYCTA specific cases add or detract from overall course effectiveness?

add 22
detract 1

10) As a result of this course, your job performance will:

4 improve significantly
19 improve somewhat
0 no impact expected
0 deteriorate somewhat
0 deteriorate significantly

11) Overall course rating (0-10); 8.4

RESULTS

A pilot offering of the training program was given to a group of 24 transit middle-managers. Twenty were from NYCTA, and 4 were from other New York City area operators. The course was given for five straight days beginning January 25, 1982; the remaining five sessions were given on consecutive Wednesdays, ending on March 3, 1982.

Four separate evaluations were conducted on the pilot course, and each was quite favorable. The instructors have all returned to the shop floor of the transit system to improve the design for future courses. The course has received UMTA endorsement under Section 10 of the Urban Mass Transit Act of 1964 (P.L. 88-65), and NYCTA has proposed that Polytechnic make changes specifically for that system. Following those changes, NYCTA middle-managers will be trained separately during additional course offerings. Eventually the program will be transferred from Polytechnic to the NYCTA's own in-house instructors.

Figure 1 summarizes the results of the course evaluation questionnaire filed by participants. Separate evaluations conducted by NYCTA are supportive of these results, as are the comments of instructors and official UMTA and NYCTA observers.

FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

The overall results support the initiatives taken by Polytechnic, UMTA, and NYCTA. The findings are based on carefully designed assumptions, applied research into the needs of mass transit systems for the design of a curriculum for management development, a pilot training course, four evaluations, follow-up course development activities, and plans for extensive course offerings in the near future.

The following conclusions have been formulated:

1. The needs of transit middle-managers are best met by system-specific training, not general management curricula.
2. The case-study approach is an effective tool for the training of middle-managers, who tend to rebel at traditional classroom learning.
3. The development of appropriate cases requires extensive on-site research, and the design of curricula requires the active participation of executives of the transit system.
4. There is a critical need for understanding of the lives of operating managers and to reflect their reality in training. The crucial element is to have instructors conduct need analysis studies and other research on the shop floor in order to develop an empathetic orientation and rapport with the participants in their natural work setting.
5. Training must lead to development of useful tools that can be implemented rapidly by transit middle-managers. These tools should result in improved conditions within a relatively short time frame. The value of new techniques must be quickly reinforced in the work experience.
6. Case studies should be prepared separately

for the primary transit functions, but mixed groups are encouraged. They result in team building and a greater appreciation for overall organizational operation.

Polytechnic's training program is a unique university-industry cooperative effort for training that appears to be successful. It represents just the beginning of appreciation for the potential role that universities are able to play in providing management training to transit systems. Management faculty teamed-up with transportation faculty can offer transit systems state-of-the-art approaches for solving persistent problems that top management has merely adapted to rather than solved.

The specific role for universities shown by this project is as a consultant to managers of training programs. The need for training departments to enter the world of operating managers and develop training programs based on skill deficiencies that cause performance problems is the key element of the program. The role of the university was in the identification of these deficiencies and the design of a curriculum to correct them.

The shift of emphasis in transit training from instruction in general managerial training courses and into the role of internal consultant is the key to success. The strategic orientation of training departments should be based on changing the organization and not on educating it. The new role would then be toward organization development in addition to, not instead of, skills training.

The university offers expertise in the performance of analysis techniques, approaches to behavioral modeling, applications of team building in training (to build empathy and personal networks among managers across functional positions), the application of strategies for organizational change to training courses, and many other state-of-the-art possibilities. Teams of faculty can also provide transit operators with appropriate mixes of expertise in management, transportation, industrial engineering, and other specialties.

One elaboration of the techniques suggested previously, for example, would be the application of strategies for organizational change. One of the many approaches used in private organizations by management consultants is diagnosis of systemic problems based on confidential interviews. This bottom-up approach focuses on the participative formulation of problems by category, impact, and cause. It also protects those participating managers from recrimination in low-trust climates. The formal diagnosis provides management with a map for action. Where problems are based on skill deficiency, training programs may be designed that focus on the skill deficiency that is causing the performance problem.

Diagnostic techniques can be taught to training department personnel on a phase-out agreement with the university team. Where trusting climates exist, systematic group meetings for diagnosis contribute toward the goal of team building as information is gathered for the formal diagnostic report. The overall approach toward helping the organization change is organizational development, just one of the many possible beneficial relations that can be formed between university faculty teams and transit agencies. Where universities and transit operators can form cooperative working teams, the results are seen in more effective training, which increases the potential for significant improvements in performance.

A detailed report on this training program has been submitted to UMTA and is available through the Polytechnic Institute of New York (1).

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Introduction: Revolution or Evolution in Transportation Education?

MICHAEL D. MEYER

The transportation profession is facing a fundamental change in the approaches used in analysis. The catalyst for this change has been the development and rapid use of microcomputer technology and software throughout the profession. Many of the transportation engineering and planning exercises that were once done manually or required extensive computer application have been adapted to a microcomputer environment--easy to use with rapid turnaround. At a recent seminar sponsored by the Institute of Transportation Engineers, 25 percent of the transportation professionals today were estimated to use microcomputers. Within two or three years this number might reach 50 percent or more.

The rapid introduction of the microcomputer into the profession places a special burden on transportation educators. Universities must teach students with this new capability and prepare them for this new working environment; however, a dilemma arises over the approach used to present this material. One school of thought argues that the technique provides the answer and all one must do is train students how to use the technology. Another group argues that, although the technology is important, students must still be educated in the approaches and procedures that produce the answers.

The two papers that follow address the issues related to this educational dilemma. These papers represent the beginning of a debate that might last for some time.

Computer-Assisted Learning in Transportation Engineering Education

ERIC I. PAS

Recent technological advances have led to microcomputers with enhanced capabilities at reduced costs. The introduction of cheap and powerful microcomputers has contributed to renewed interest in the use of computers as learning aids. The recent revival in the use of computer-assisted learning (CAL) is outlined in this paper. Three examples of transportation engineering applications of CAL are described and assessed. These applications are used to discuss important considerations in the development of CAL materials for use in different situations and to illustrate some of the benefits and limitations of this educational technology. The major objective of this paper is to stimulate interest in the appropriate use of CAL in transportation engineering education.

The use of digital computers as instructional aids began in the 1960s after the introduction of third-generation computers, which supported interactive (or conversational) computing. The computer was seen as an ideal tool for delivering the type of programmed instruction that was developed during the 1950s and implemented originally by using so-called teaching machines. Thus, the intellectual roots of early computer-assisted instruction (CAI) were in the programmed instruction movement of the 1950s.

Programmed instruction, which was based on Skinner's theories of learning, emphasized rote learning, immediate feedback, and reinforcement and allowed little individual adaptability. As a result, early CAI did not make good use of the computer's capabilities, and this is one of the major reasons for the initial dissatisfaction with the technology. Recent advances in computer technology have led to renewed interest in the use of computers in education and may provide a second chance for CAI (1). In particular, the reduced costs of microcomputers, coupled with enhanced capabilities (including color graphics, sound, and substantial random access memory), have stimulated the renewed interest in CAI.

The remainder of this paper is organized as follows. First, we review briefly the field of computer-assisted learning (CAL) as it exists today. (Computer-assisted learning is the term used in the remainder of this paper. This distinguishes the more recent applications of computers in the educational process from the computer-assisted instruction of the 1960s.) Second, we describe and examine three example transportation engineering applications of CAL that cover a range of the potential uses of CAL. In describing the sample applications we pay particular attention to the general structure and characteristics of the instructional materials to allow the reader to develop an appreciation of some general considerations in the development and use of CAL materials. Finally, we suggest some other potential applications of CAL in transportation engineering education. The major objective of this paper is to stimulate interest in the appropriate use of the CAL technology in transportation engineering education.

A brief description of some terminology used in this paper is useful. Courseware refers to course-related software. CAL material refers to computer software, worksheets, and user's manuals. A module is the smallest individual unit of CAL materials, typically of 15-25 min in duration. A packet is a collection of related modules.

CAL TODAY

Computers are used in education for many different purposes, including counseling and guidance, curriculum evaluation, testing, management of instruction, information retrieval, development of computer literacy, as well as for CAL (2-4). CAL, the focus of this paper, may be defined as the direct use of the computer in the presentation of instructional materials.

Today computers are employed as learning aids at all educational levels, ranging from preschool to college. CAL can be used for a variety of purposes, including drill and practice, tutorial, simulation or gaming, and problem-solving (5). The different modes of use can be classified conveniently according to whether the computer is primarily used as a medium or a tool. For example, the computer is primarily a tool when used as a computational aid in problem-solving. However, in the educational context, it is important that the student does not use the computer as a black box. Thus, in this context, the computer is used primarily as a computational tool and should also be a medium of instruction.

Despite the high level of recent interest in CAL the new technology is used relatively little at the college level, particularly in engineering. College-level applications described in the literature include physics (6), chemistry (7), economics, and business (8). Engineering applications tend to focus on structural analysis and design and electrical engineering and electronics. Cases in which computer software has been developed specifically for use in transportation engineering education are particularly hard to identify. One exception is the Transportation Teaching Package (TTP) developed at the Massachusetts Institute of Technology. In addition, some limited use has been made of industrial software in transportation engineering education. For example, Fisher (9) describes the use of the Interactive Graphics Transit Design Systems (IGTDS) package at Cornell University. However, in neither case is the computer used directly in the presentation of instructional material.

Computers are used extensively in the practice of transportation engineering and planning. Thus, the question that should be addressed is, Why not simply employ existing commercial and industrial software in educational programs? Two important reasons why the software used by practitioners is generally not suited for application in the educational context are as follows:

1. Computer programs (and accompanying documentation) used in practice appropriately assume that the user is already familiar with the basic principles and techniques. On the other hand, the objective of using the computer in education is to assist the student in learning the fundamentals.
2. Industrial and commercial software is very general and flexible, as indeed it should be. As a result, a potential user is often required to spend a large amount of time merely learning how to use a specific program. For example, the U.S. Department of Transportation offers a one-week training course to teach experienced transportation analysts how to

Table 1. Characteristics of sample CAL applications.

Name of Packet	General Description	Environment	User	Mode	Function of Computer
NETWORK	Illustrates network assignment techniques	Classroom	Instructor	Simulation	Medium
TRAFLOW	Reviews basic concepts of traffic stream flow	Computer laboratory	Individual student	Review and tutorial	Medium
UTP	Computational aid for urban transportation planning studies	Computer laboratory	Small group or individual student	Problem-solving	Tool

use the Urban Transportation Planning System (UTPS) package. In a college-level curriculum the primary emphasis should be on the study of the basic concepts, principles, and techniques, and little time should be devoted to the use of specific computer packages.

Thus, we need to examine the use of CAL in transportation engineering education and to develop CAL materials where appropriate.

APPLICATIONS OF CAL IN TRANSPORTATION ENGINEERING EDUCATION

The objectives of this section are to illustrate some potential uses and benefits of CAL in the context of transportation engineering topics and thereby to stimulate interest in the appropriate use of this technology in transportation engineering education. The summary information in Table 1 gives the three CAL examples described here. They cover a broad range of the possible applications. Two of the applications are designed for use by students in the computer laboratory environment, and the third application is designed for use in the classroom by the instructor. One of the computer laboratory applications is intended for drill, practice, and tutorial work; the other is designed as a computational aid. In two of the example applications the computer is used primarily as a medium; in the other application the computer is used primarily as a tool.

Example 1: NETWORK

The objective of the NETWORK packet is to aid students in learning network assignment techniques used in transportation systems planning. NETWORK is designed for in-classroom use by an instructor. The NETWORK packet currently consists of three modules, SPA, FHWA, and CREATE. SPA and FHWA demonstrate a particular shortest path-finding algorithm (10) and the Federal Highway Administration's iterative assignment technique (11), respectively. The third module, CREATE, assists the instructor in preparing example networks.

Features

The computer can be used in the classroom to display time-dependent phenomena or to illustrate three-dimensional objects or processes. The SPA and FHWA modules are based on the notion that, by considering the steps in an iterative calculation as being steps through time, one can employ the computer in the classroom to demonstrate iterative solution techniques. Because the phenomenon we are studying in this case has significant spatial properties, the use of computer graphics to display the results after each iteration is particularly effective. The computer also gives us the ability to demonstrate the answer to what-if questions. For example, What happens if a particular link is removed from the network? Furthermore, the computer display provides a dynamic quality that is hard to replicate, even with a series of viewgraph overlays. Thus, the computer can be an extremely useful device in demonstrating iterative solution techniques or algorithms.

In the SPA module computer graphics are used to further improve the module as a teaching aid by careful integration of graphical and numerical representations of the solution procedure. Figure 1 shows the layout of the computer monitor screen for the SPA module and indicates how the mathematical and graphical displays are integrated at each step of the solution procedure. That is, we integrate a graphical representation of the development of the shortest path tree, and the computations undertaken at each step and the contents of the various arrays are displayed.

When CAL materials are intended for use by instructors as in-classroom instructional aids, the instructor's role must not be to simply turn the equipment on and off. Two specific guidelines follow from this observation. First, the instructor should be able to control the detail and the tempo of the display. For example, the SPA and FHWA modules allow the instructor to select either intermediate display of calculations or display of final results only. Furthermore, if the instructor chooses intermediate display of calculations, three different tempos are available--slow or fast fixed time display and user-controlled time display.

A second guideline that follows from the need to make the instructor an integral part of the lesson is that the module should be designed to allow (and encourage) the instructor to interact with the students. That is, to provide the instructor with a speed control is not sufficient. As opposed to CAL modules to be used by students in the computer laboratory environment, in-classroom instructional aids need not be completely self-explanatory. Thus, the instructor has the opportunity to interact with the students. In this way the CAL module functions as an instructor's aid.

One of the important benefits normally associated with CAL is that the student is an active participant in the learning process (12). However, in the case of in-classroom courseware, a specific mechanism, such as the use of worksheets, is needed to encourage student involvement, otherwise the use of modules like SPA and FHWA could be detrimental to learning.

Assessment

The students generally reacted favorably to the NETWORK packet. Only one-sixth of the respondents to a questionnaire agreed with the statement that CAL has little use in the classroom environment. However, one-third agreed with the statement that CAL modules should be used in the computer laboratory environment but not in the classroom. Most of the students thought that the NETWORK packet does not obstruct instructor-student interaction nor render the instructor redundant.

Based on the responses to the questionnaire and the instructor's experience, some general guidelines

Figure 1. Screen layout and integration of graphical and mathematical representations in the SPA module.

Display of Complete Network (A)	Display of "Current" Shortest Path Tree (B)
Record Keeping* (C)	Calculations/ Decision-Making** (D)

STEP 1: display example network (A)

STEP 2: display initial status of arrays (C) and the origin node (B)

STEP 3: display calculations undertaken to select the arc to be included next in the tree (D)

STEP 4: show selection of arc to be included (D)

STEP 5: show the updating of the arrays (C) (mathematics), and show the updating of the "current" tree (B) (graphics)

STEP 6: repeat steps 3 through 5 until shortest path tree is complete

* - display of contents of arrays used in shortest path tree calculations

** - display of the computations used to select the arc to be included next in the shortest path tree

can be formulated regarding classroom use of CAL materials. First, the CAL presentation should occupy no more than approximately one-half of the lesson. This allows the instructor adequate time to introduce the subject matter, motivate student interest in the topic, and answer questions prompted by the CAL presentation.

Second, the development of good worksheets is important to the successful use of CAL in the classroom. The worksheets were found to be useful in preventing students from becoming merely passive observers. However, the worksheets must be coordinated carefully with the computer display. The worksheets may be employed to record a limited quantity of the results and calculations, but they should not be used merely for students to copy large quantities of numbers displayed by the computer. Alternatively, worksheets may be used to allow students to anticipate the forthcoming computer displays. The idea of competing (in a sense) against the computer encourages student participation.

Third, if possible, a version of any CAL module employed in the classroom should be made available for individual student use in the computer laboratory. This allows students to review the material at their own pace. Finally, the successful use of CAL materials in the classroom is dependent on the availability of suitably located monitors to ensure that all students are able to see the computer display clearly.

Example 2: TRAFLOW

The TRAFLOW packet is designed to aid students in reviewing and studying basic concepts of traffic stream flow, including density, speed, and flow, and the relations among these variables. For example, one module in this packet allows the user to fit a linear speed-density model to a set of data and to explore the corresponding speed-flow and flow-density relations. TRAFLOW is a drill, practice, and tutorial packet designed for computer laboratory use by individual students.

At present the TRAFLOW packet comprises six modules. Briefly, the function of each of these modules is as follows.

1. INTRO--Provides information that allows the user to determine whether to use this packet, which section is an appropriate starting point, and how to use the packet;
2. PRETEST--Enables the user to assess and improve his or her understanding of the fundamental concepts that are prerequisites for the other sections of the packet;
3. PLATOON--Presents data concerning the movement of a platoon of vehicles over a highway segment; the data enable the user to compute traffic stream flow characteristics in response to questions posed by the module; the data are generated randomly and the user may choose to repeat another problem of the same type as many times as desired;
4. LINEAR--Presents a speed-density plot of field-collected data (13); the user is able to fit a linear speed-density model to the data and is then guided through an examination of the corresponding speed-flow and flow-density relations;
5. NONLIN--Introduces the user to the idea of nonlinear speed-density models and the implications of this form of the speed-density model for the corresponding speed-flow and flow-density relations; and
6. SUMMARY--Provides a summary of the material in the packet and allows the user to obtain a printed copy of a list of references that deal with the basic concepts of traffic stream flow.

Features

A number of features are incorporated in the TRAFLOW packet. A simple set of commands allows the user to control the lesson. The user may choose to advance to the next frame, start the module again, end the module, skip to another module, or leave a message for the instructor. The latter option can be particularly helpful in providing feedback for the instructor and in allowing the user to express any frustrations that may have been generated by the CAL package.

At the end of each series of questions the user is provided with an evaluation of his or her performance. The ability to provide rapid feedback is an important characteristic of CAL technology, yet a number of drill, practice, and tutorial packages do not provide any assessment of the user's performance. The TRAFLOW packet provides for individualized learning in that the user is given the option of receiving additional explanations when desired. The user is also able to select the order in which the different topics are reviewed or studied, after being supplied with the information needed to make such decisions. Grubb (14) makes a strong argument for granting the user more control in order to allow for wide differences in individual backgrounds.

Assessment

All of the students responding to the questionnaire thought that CAL modules generally have a use in the drill, practice, and tutorial modes, and they enjoyed using the TRAFLOW packet. All the respondents considered TRAFLOW to be an effective aid in reviewing the basic concepts of traffic stream flow, although not as effective as individual interaction with the instructor. All of the respondents availed themselves of the opportunity to obtain a hard copy of the references, but few left messages for the instructor.

A number of the students thought that they could have been better prepared before using the TRAFLOW packet; in particular, by suitable review of their class notes. A drill, practice, and tutorial CAL packet should not require that students be thoroughly familar with the subject matter before using the packet. Although the TRAFLOW packet assumes that the user has been introduced to the basic concepts, it is designed to assist students in reviewing and understanding these concepts. The reason why a number of the students though that they could have been better prepared is not clear.

The majority of the respondents thought that the answers provided are not detailed enough for effective learning. In particular, two important considerations emerged. First, an explanation of the recommended solution should be provided rather than just a step-by-step account of the solution procedure. Second, even if a student answers a question correctly, he or she should be given the option of requesting an explanation, particularly if a multiple-choice format is employed.

Example 3: UTP

The objective of the UTP packet is to aid students in carrying out the repetitive and time-consuming calculations necessary for an urban transportation planning case study undertaken in the introductory transportation engineering course at Duke. The case study, which is based on one developed by Morlok (15), uses a very small, hypothetical study area and is undertaken by groups of three students each. A large number of repetitive computations are needed to examine each alternative transportation system for the study area. The UTP packet is designed for use in the computer laboratory by individual students or by small groups. The packet's design prevents its use as a black box. That is, the packet does not eliminate the students' need for understanding the basic principles and techniques.

The UTP packet comprises three modules, INTRODUCTION, GRAVITY, and BALANCE, and at least three more are planned. Each module is designed to constitute a single session at the computer. Each of the modules, other than the introductory one, is designed to deal with one phase of the analysis of an alternative transportation system.

Features

Problem-solving is one of the variety of modes in which the computer can be used in the educational context. However, some educators believe that the use of computers as computational aids can be detrimental because it reduces the students' need for understanding basic principles and techniques. For example, de Silva (16) has published an article entitled, The Computer: Obstacle to a Meaningful Engineering Education.

The UTP packet is based on the belief that suitably designed software can be used successfully as a problem-solving tool in the educational environment. In developing the UTP packet we hypothesized that the reduced time and effort needed for calculations would encourage students to explore a greater variety of alternative transportation plans for the study area. Furthermore, we hypothesized that the UTP packet would allow the students to gain improved understanding of the basic concepts, relations, and techniques, as long as it could not be used as a black box.

The characteristic that best distinguishes the UTP packet from software used by professional transportation planners is that the UTP packet is structured on the assumption that the user is inexperienced and is relatively unfamiliar with the principles and techniques. The user is therefore required to develop and demonstrate a thorough understanding of each particular computational technique before being able to employ a given module as a computational aid. The package is also designed for use with only a limited range of problem types, in contrast with the flexibility necessary in industrial software.

Each module includes a number of questions to probe the user's understanding of the planning process and model system. In particular, the input and output variables for each model are reviewed. An incorrect response to a question automatically generates the correct answer as well as additional information concerning the modeling technique being employed. After completing the question segment of a given module, the user is asked to input the data required for the calculations and to provide the first series of results. These results are examined for consistency relative to the input data provided by the user. If the calculated results are incorrect, the user is so informed and is given another opportunity to perform the calculations manually. Correct results enable the user to proceed with the use of the CAL package as a computational aid in the current and subsequent sessions. The module is therefore able to provide many of the insights usually obtainable only through manual computations and also eliminates tedious and repetitive calculations.

Assessment

Student reaction to the UTP packet was generally positive. More than 70 percent of the users found the modules useful, mainly for simplifying computations. Only 18 percent of the users found the modules to be of no help in improving their understanding of the transportation planning methods and in formulating questions to be discussed with the instructor. Furthermore, only 12 percent thought they would have learned as much as they did from the case study project without the UTP packet; about 40 percent of the respondents appear to have used some of the modules for personal review of the material. Only one respondent thought that the UTP packet rendered the instructor unnecessary, and about a third of the respondents thought that the help provided should have been more detailed.

The success of the UTP packet is confirmed by three observations made by the instructor and teaching assistant. First, the UTP packet encouraged considerable interaction among the group members--probably because the computer engages the students in an us versus the machine situation. Second, some groups undertook analyses that were not attempted the previous two times the case study was assigned, without the availability of the UTP packet. This was probably due to the reduced amount of time spent on the calculations as well as the greater insights gained. Third, the course evaluations in the past have revealed that the students generally find the case study project interesting and didactic, but extremely time-consuming. However, the previous complaints about the large amount of time spent doing repetitive calculations were absent when the UTP packet was available. A more detailed assessment of this packet is provided elsewhere (17).

DISCUSSION OF RESULTS

Relatively little use has been made of CAL in transportation engineering education, despite the extensive renewed interest in this technology during the past five years. Because of the potential benefits of careful and appropriate uses of CAL, transportation educators should begin exploring possible applications.

Three examples of CAL applied to transportation engineering topics are described and assessed in this paper. These examples demonstrate some potential uses of CAL in different contexts in transportation education. The examples indicate potential benefits of CAL in transportation education and they highlight some of the considerations that are important in developing CAL materials in different contexts. This paper shows how the computer can be used effectively in the classroom to aid the instructor in demonstrating an iterative solution technique. The paper also describes how the computer can be used appropriately as a problem-solving tool in the educational environment.

An area of transportation engineering that should be explored for potential use of CAL is the collection and analysis of field data. In some cases the real-world process could be simulated effectively on the computer in such a way as to allow the student to gain a good understanding of the data collection and analysis procedures. Such applications could eliminate the need for field equipment and reduce the time needed to acquire the necessary skills. Computer simulations of chemistry and physics experiments are already in use. A second area of transportation engineering in which CAL might be employed is geometric design. Computer graphics could be used to demonstrate the interaction of the various design elements--both in the classroom and in the computer laboratory.

The potential usefulness of CAL in transportation engineering education has been demonstrated in this paper. An indirect benefit of CAL is that students become more comfortable with the use of computers and they see the range of tasks that can be accomplished with a computer. The example applications illustrate some of the considerations that are important to the successful development and use of CAL. Transportation educators should begin to explore this powerful educational technology. In addition to considering the guidelines presented and discussed in this paper, the interested transportation educator should examine the ideas presented by Bork (18), Eisele (19), Nievergelt (20), and Spitler and Corgan (21).

Finally, CAL is not the solution to all educational problems, and transportation educators should evaluate carefully the application of this technology in their courses.

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Computer as Horseless Carriage: Transportationists for the 1990s and Beyond

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Individuals and organizations active in a particular technology form are often unable to perceive the direction and magnitude of change in their area when the impetus for the change is external to their technological (or disciplinary) area. An analogy between the impact of the evolving characteristics of computer systems and the development of the automobile is developed with respect to their impacts on transportation. The near future character of computer systems is examined with respect to the manner in which each characteristic is likely to impact the processes of transportation and traffic engineering. Three examples of probable impact areas in transportation engineering are discussed: (a) traffic control safety by using the principles of positive guidance control, (b) site analysis for traffic environment effects, and (c) data base development and manipulation. Lastly, and most importantly, the capability of the computer to integrate the fragmentation of specialized talents with transportation practice is discussed. This probable and most significant effect of computer-aided communication in transportation suggests that a new focus, distinct from and more broadly based than the current paths to practice will develop; i.e., the transportationist.

The appearance of the automobile early in this century produced at least three viewpoints. The first saw the automobile as a meaningless and doomed fad. The second saw the automobile as merely an engine-powered (i.e., horseless) carriage. The former view simply misjudged the utility and impact of the invention; the latter view saw the potential for change, but perceived the automobile to be merely a linear extension of extant technology. A third, uncommon view, foresaw that the automobile would remake all industrial societies in its wake, as in due course, the automobile did change the way people live, work, and seek recreation.

The computer can be seen in analogous terms. Tracing the thread of recent U.S. history (in general terms) for those who perceived the automobile in these three terms may provide instruction on how a failure to properly respect today's computer may affect transportation professionals. A few selected examples of current interest will be examined.

THREE VIEWS

Meaningless and Doomed Fad

When the automobile was invented and fledgling tinkerers began to build these contraptions for sale, many individuals scoffed at both the invention and the would-be entrepreneurs. Cynics looked at the invention and saw only its limitations and failures: It could not swim a stream like a horse; it required that cans of messy fuel be carried; when it threw a wheel (as a horse was apt to throw a shoe) several strong people were needed to push it home, but a horse could walk; and, of course, if God had intended people to ride that fast He would have created them without legs!

It is rather humorous to read some of those accounts today; however, does a parallel exist in the transportation engineering field (education, training, operations, design, and analysis) with respect to computers? How different is the attitude of the supervisor of an engineering office who views the computer as a device that permits employees to make more mistakes faster? How realistic is the engineering office manager who thinks a computer is for computations and an electronic typewriter with memory is for word processing, thereby failing to realize that the computer function is the same on a machine equipped to do both? What is the depth of technological vision of a traffic engineer who regards traffic signal timing as a closely guarded art and fails to see in computer graphics stick drawings the precursor to a media format by which a technician with one-half the engineer's education can determine optimum signal timing settings?

Engine-Powered (Horseless) Carriage

People who looked at the embryonic stage of the automobile industry as the carriage with a mechanical device to replace the horse were correct initially. What they saw were the efforts of mechanics to get engines to operate reliably. These engines were the focal point of the mechanics' interest and were attached to convenient buckboards, surreys, or whatever was available. These people thought that the ways a horse and carriage were used were the ways in which an automobile would come to be used. Because speed and power had always been sought in horses, it was reasonable to assume that automobiles would be improved in the same manner. However, persons thinking of a horseless carriage did not envision the impact that environmental protection of the occupants and cargo could bring, thus opening the way for frivolous uses of transportation. Even today, many engineers think of the automobile as a utilitarian unit of transportation. Psychologists, sociologists, and marketing analysts have long known that the automobile's utilitarian function is often secondary to other images and values attached to it.

Where lies the parallel in the computer age in 1983 through 1990? Some technologists and social analysts regard the modern computer as a linear extension of the familiar and uncomplicated hand calculator. Such an image of the very small but highly sophisticated devices coming on the market creates a smaller-but-same mind set, thus limiting their vision of microcomputers. A similar error occurs at the opposite pole when people think of a computer as only the large-capacity mainframe unit with high-speed printers, numerous disc and tape drive units, and several people hovering over the system day and night. The smaller-but-same perspective prevents a person from envisioning the way communication of people in expressing their creative thoughts may be enhanced by one-on-one interaction with the computer, as opposed to the at-arms-length interaction associated with mainframe computers.

Remaker of Society

Those who saw the automobile as a catalyst for change were opportunists. Some sought a fortune in finding oil to produce fuel to power a future fleet of automobiles. Some chose to create an empire by providing the automobile in a variety of dimensions. Some aspired to acquire an automobile for personal use to increase access to potential mates, to potential jobs, to health care, and to a view of different terrain.

In the computer age those opportunists also exist. The computer has already begun remaking industrial societies as completely as did the automobile. The reasons for and the importance of this reality must be understood. More specifically, everyone working in the field of transportation should know what this scenario bodes for transportation activities; this is the topic of this paper. The question raised is the extent to which the current structure of the academic world prepares its clients to be problem solvers of the sort that will be needed. Currently the nature of education (in the United States particularly) engenders a form of tunnel vision that focuses on disciplinary issues. This focus may be producing a trained incapacity on the part of students who graduate from such a curriculum.

COMPUTER AS A THING IN ITSELF

The computer is not merely a linear extension of the hand calculator. Rather, the computer has already begun to manifest abilities that will render moot the artificial intelligence (AI) debates of the past two decades. Who really cares whether a machine thinks if the machine is capable of making decisions within limits set by the owner and over which the owner needs to perform no oversight? The question of whether machines think or reason is not a question asked by those in the trenches. As a case in point, the first traffic signal in the United States was changed manually by a policeman who exercised his judgment as to timing and sequence. Much later detectors and analog computers were employed for the same purposes as microprocessors are today, namely the control of sequence and timing. Whether the microprocessor thinks is irrelevant, for it performs a formerly human job much faster and with near-perfect reliability.

The most important power of the computer, relevant to transportation, may be its capacity to diminish the number of tasks. That is, it can integrate formerly divergent activities. The computer does this by virtue of its strengths--speed and power.

The slowest microprocessor circuits still perform repetitive tasks with a speed and accuracy unthinkable only a generation ago. The telescoping of time perception that occurs among computer users, happily, tends to render such terms as slow and fast obsolete.

Computers possess almost fantastic powers to sort and perform decision making based on predetermined criteria. A newly marketed Japanese ship can be operated with a single person on the bridge who communicates with the computer by speaking English. The sheer size of memory in modern computers is virtually the only limitation on the analytical tasks to which they can be assigned.

The merger of video and digital discs with computers will effect changes in information access that will equal Guttenberg's contribution of inventing movable type. An example of the potential changes that the new technology will accomplish can be found in the present practice of photologging, where a time-lapse movie camera synchronized to the speed of an automobile photographs a roadway (1). The resultant filmstrip, showing the roadway in measured intervals, can be used to study the number of driveways, advertising signs, and bridge approaches during a period of time. By using videodiscs, the filmed information could be transferred to the discs and accessed with multiple video machines controlled by a computer to show any single section of roadway during any period of time without any time lag due to reel switching. Furthermore, the useful life of the videodisc would theoretically be longer than the life of the roadway. At some point all similar bridges could be seen in sequence or safety ideas from other sites could be examined by comparison with a problem site.

All this could be done without leaving the office. The U.S. Department of Defense is using prototypes of this sort of video-computer interface to train tank drivers and has a cruise around San Francisco Bay test version that has been demonstrated publicly.

Range

Unlike humans, the range of tasks that a computer can undertake is almost limitless, from the numbingly boring tasks performed by industrial robots to tasks done by home computers that operate lighting or automobile cruise controls. The cruise-control microprocessor replaces mechanical servomechanisms of a generation ago. It constantly monitors speed and relays correction commands to engine operations. At the opposite extreme would be the elaborate aircraft simulators operated by United, American, and Lufthansa airlines. In these the number of variables simultaneously manipulated by the computer is enormous.

Friendliness

In the jargon of computerists, friendliness refers to some combination of intimidation factors and transparency of the operating system. At a more abstract level it can refer to the tendency of computers to produce interactions with human beings in a format that is easier to digest than were the esoteric initial outputs. For example, those doing research quickly find that reams of printouts containing tables and correlation matrices may mask rather than enhance significant findings. The newest computers, by using sophisticated graphics and plotting tools, can put statistical data into physical forms that allow the researcher's intuition to reenter the research process. Computers also are beginning, through natural language programs, to literally speak our language. Beyond the computer-piloted ship already mentioned, speech-to-text and text-to-speech computers hold the promise of forever altering our relation to the printed word.

The next step in simple technology such as traffic control devices may be the abandonment of unique and convoluted adjustment and reprogramming procedures now employed by every manufacturer. At some point in the future a policeman with proper codes may speak into a microphone on a traffic signal pole and tell the computer to alter sequences and timing to conform to some special event or emergency. Expensive training to manage special events and dangerous errors in adjustment would disappear.

REMAKING THE TRANSPORTATION FIELD

The power of the computer to integrate tasks will be as obvious in the field of transportation as in any other. More specifically, what it will offer to the next generation will be the opportunity to bring under one umbrella tasks that were separated only because of the technology and customs of earlier times. The number of possible examples are many and varied; some obvious ones are described in the following section.

Beyond Positive Guidance Control

The traditional positive guidance control (PGC) method is likely to become, at some time, merely a subcategory of an integrated computer graphics and videodisc method. By using PGC, engineers or safety analysts currently draw up an accident history for a problem site and generate a checklist for potential driver confusions that could occur relating to signs and road stimuli. From this a recommendation is made as to changes short of rebuilding the site. PGC, a combination of human factors and traditional engineering tasks, may become more technically independent if the computer is put to work in currently available ways. First, the site could be analyzed item by item by using computer analysis of stored categories of signs, stimuli, and frequency factors. Actual changes could be programmed into graphics displays for testing with volunteer subjects, with the computer controlling the addition and subtraction of elements until an optimal solution is reached. Videodiscs could be used on isolated sites where sign changes and stimuli removal could be made via computer graphics overlays to the video image. After sufficient trials under these standardized conditions, certain stock answers would be obvious, whereas today each intersection or site tends to be dealt with idiosyncratically. Thus, the tasks of the human factors specialist and the civil engineer may be blended into a more integrated and functional role.

Site Analysis

The expanded PGC procedures described can also be applied to site analysis for the construction of bridges, roads, and buildings. The computer graphics and videodisc technology will one day permit the videotaping of a site and the conversion of those images into a realistic graphic display, with the result that elements can be almost infinitely put in or taken out in order to study the overall effect. Coupled with already extant analysis programs that provide running tallies of materials stresses, fatigue points, and costs, such analysis would again represent an economy and integration of effort. The computerization of movie backgrounds (i.e., sets) suggests that the geometry of fixed site parameters could easily be digitized. The site development could be tested in much the same manner that a computer-generated cartoon is created so the nonengineer can see the impact of proposed developments.

Considerable improvement could be shown in the design and placement of such ordinary structures as parking lots, parking garages, and simple entrances and exits. By using the techniques suggested here, substantial improvement could be made in trying out various solutions to problems at low cost.

Data Representation and Interpretation

The sheer volume of data now being generated is a substantial problem. Many of our colleagues ask whether anyone is reading the data we are grinding out. Unfortunately, the answer is often a resounding no. Even professionals often are no longer willing to wade through a maze of summary statistics generated on even small research and traffic analysis studies. The reason for this problem is that it is thought that, once generated, the data should be shared, although many would appreciate less rather than more generosity.

One likely development is the creation of better visual representations of data. More important, the analytic power of the computer must be put to work to generate something that transcends simply faster computing than can be done by humans (beyond the horseless carriage). There often turn out to be what one sociologist referred to as deep structures--large-scale forces or processes not evident from superficial analysis (2). For example, typical correlational analysis of driving behavior does not usually verify patterns of automobile use that we all know are evident, including social class and cultural differences. What transportation badly needs is knowledge of what other hidden factors are at work in perception, attention span, and other human-factor problem areas. As soon as users know the proper questions, the technology of modern computers will permit better answers.

In the area of effects and applications, transportation does a poor job of representing itself to laymen and nontechnical publics. Particularly, nontechnically trained persons in decision-making positions (e.g., legislatures and executive offices) tend not to respond to the kind of technically satisfying presentation found in most transportation analyses. A case in point is the difficulty recounted by Hochstein (3) with regard to the Westway freeway and one comment his article elicited (4). Nontechnically trained decision makers need to see the projected or potential effect of Policy A as opposed to Policy B and to see it in a scenario format that would permit rational rather than intuitive selection.

There is need for more detailed but generalized methods of data representation. In philosophical terms, what we often find when we do research is the proximate cause of an event when what we want is the remote cause, which is more deeply rooted. Forms of such analysis might include currently infant methods such as surface analysis.

Another area in which new approaches might be of use is traffic analysis of route and time factors. The standard approach involved developing algorithms for linear programming models for minimum time paths. Simulated traffic could then be loaded onto the network of minimum time path trees according to various logic patterns regarding the interaction of traffic with the network characteristics. Charnes (5), in contrast, was developing another approach that considered each originating unit for traffic (household or traffic zone) and the application of that unit's traffic to the network. The mathematical formulation simultaneously balanced the traffic-to-network interaction that resulted from building up a data base when each succeeding traffic unit formed a copy (or a layer).

Charnes' approach was seen by many researchers as impractical and difficult, yet it can, in retrospect, be seen to have some virtues. First, borrowing from the field of organizational efficiency and effectiveness, uncertainty theory (6) holds that the goal of organizational participants is to minimize uncertainty--those situations where behavior is undefined or goals are unsure. Inventions such as the left-turn penalty and volume-to-capacity restraint functions were instituted in order to compensate for the need for real-world uncertainty, but the standard approach still lacked data generated from the grassroots (i.e., in practical application it was based on aggregated data set characteristics). Similarly, Simon's (7) Nobel Prize in the field of economics was largely based on his contributions to decision theory, one element of which said that decisions are not made in organizations on the assumption that there is one single, best solution to any question. Rather, says Simon, people in organizations optimize, which is to say that they stop looking for solutions when an acceptable alternative comes along.

Relating these ideas to transportation, there is reason to doubt that statistical models of time minimization and similar maximizing solutions contain enough real-world aspects to be useful in prediction of behavior. Perhaps in retrospect, Charnes' approach, wherein the decisions of individuals can be built into aggregated data sets, may be more representative than those approaches derived from theories based on questionable econometric assumptions and statistical distributions. Modern computer graphics with computing power makes the approach of Charnes not only easily implemented but potentially more powerful.

TRANSPORTATIONISTS FOR THE 1990s

By 1990 the functions of the transportation planner, researcher, traffic engineer, and technician will begin to be integrated. The integration of these functions will occur because of the capacity of interactive computer-video devices to process and sort vast amounts of information rapidly. The new role may come to be called that of transportationist. This new name suggests that the person who fills that position will be a problem solver dealing with transportation. This, in many respects, is what motivated many individuals to enter their fields in the first place and exactly what policymakers and planners often think they are getting when those persons are hired. Let us hope that expectation and reality come to be more closely aligned. A few writers have recently begun to consider the shape of transportation in a resource-scarce era (8,9); however, few have tried to deal with it universally.

The microcomputer and advanced computer graphics in existence in January 1983 permit some of this diffusion of technological disciplinarity. The FHWA computer system for testing traffic signal timing, NETSIM, has the capability, through time compression of the graphic output, to make the mathematical models completely transparent to a person testing a signal timing plan. Therefore, a person can evaluate the goodness of the signal timing intuitively as well as examine numerical criteria. Furthermore, it is possible to relate the numerical engineering data to the visual feel of the network operation. This is a new communication capability.

The accounting spread-sheet programs (such as Visicalc) are being recognized as a convenient and rapid means of organizing and carrying out the computations previously done by hand with a slide rule or calculator or by a mainframe computer program for selected engineering analysis techniques. Two such examples are the development of the velocity profile for operation of a train on railroad grade and the analysis of a truck escape lane (arrestor bed) on a highway grade. Perhaps it is easier for the engineer and the policy analyst to understand each other when a bookkeeping device handles the calculations and a computer graphics display unit presents a diagram of the results.

One final example from highway signing is suggested. In urban areas where sign control ordinances govern both private and public signage, the application of the Manual on Uniform Traffic Control Devices (10) and the application of outdoor advertising principles often conflict with the local ordinance application. Computer graphics offer a means for comparing technical requirements with aesthetic requirements and economic requirements simultaneously or for examining each in turn in short intervals. If engineers, especially traffic and transportation engineers, are to be effective during the 1990s in planning, designing, operating, and maintaining the transportation system, they must become more capable in graphic art design, more articulate in visual and verbal communication, and more adept at extending their minds beyond benefit/cost ratios and sketch plans via computer-enhanced communication.

Therefore, the logical result of this process is that the educational activities related to the fields of planning, transportation engineering, and allied disciplines must become more integrated rather than more discipline-oriented. Our experience in doing funded research across discipline, college, and departmental lines suggests that no mechanism currently exists in the education industry to cope with the need for the integration of these functions. This must be the important first step in the integration of roles that is to come.

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