

Transportation Engineering and Its Role in the Undergraduate Civil Engineering Technology Curriculum

by

Thomas R. Currin Ph.D.,P.E.

Abstract:

At Southern Polytechnic State University a survey of alumni conducted in 1994 revealed that over 50 percent of the graduates were employed in transportation or transportation related fields. All of the surveyed graduates working in transportation had taken one required transportation course as part of their undergraduate experience and felt their education did not properly prepare them for their employment. Given the common practice of requiring one transportation overview course at the undergraduate level and the dearth of elective undergraduate transportation engineering courses being taught, it is speculated that many other graduates are ill prepared as well.

This paper details the changes that were made to the curriculum over the next several years which have culminated with a complete roster of undergraduate transportation courses and the establishment of only the second undergraduate ITE student chapter in the nation. Detailed herein are the challenges that were met to bring about the paradigm shift away from the notion that transportation education is solely a graduate school function to acceptance of transportation engineering as part of the undergraduate curriculum. What works and what does not at this level is presented with suggestions for others implementing such a program. In addition, a stepwise procedure for monitoring the changes via learning outcomes assessment is presented.

Introduction:

Historically, transportation engineering education has been limited at the undergraduate level. Specific topics of transportation planning, traffic engineering and highway design have been limited in depth and breadth due to the limitations of the undergraduate curriculum. In addition, educators have implied through their practice that undergraduates are too immature to appreciate the subtleties of and detail associated with these topics. It is understood that this level of detail is best left to the graduate school. This paper challenges that understanding and addresses how undergraduate transportation engineering was elevated at one institution.

This paper addresses the need, as well as the fulfillment of the need, for more transportation engineering education at the undergraduate level. Included are the identification of the problems as well as the solutions tested to resolve the problems associated with bringing this concept to fruition at Southern Polytechnic State University (SPSU). It is hoped that after reading this paper the reader will be encouraged to review his/her own institution's

transportation engineering offerings and respond to the ever-growing need for undergraduate education.

The Problem:

At SPSU ongoing surveys of alumni dating from 1994 to present have continually shown that over 50 percent of the graduates are employed in transportation or transportation related areas. The respondents are not given specific definitions of transportation or transportation related, but are given a choice from a long list of civil engineering specialty areas including, in part, structural, environmental, site design, construction, and architectural as well as the two transportation choices. Each year the sample includes all graduates within the past 5 years and is able to identify shifts in employment specialty as they develop.

It is interesting to note that the high percentage of alumni employed in transportation jobs was not anticipated by the faculty. As is suspected at other institutions, faculty assumed that the distribution of graduates among civil engineering specialties followed the curriculum's distribution of courses among specialty areas. The curriculum paradigm that the structural emphasis is most important to the success of the graduates in the workplace was not supported by the survey results. The concept that environmental specialties needed to be increased was not supported either. What was and continues to be supported is that transportation education at the undergraduate level needs to be emphasized.

Consultation with industry representatives and ITE membership further supported the need for increased undergraduate transportation education. The department's industrial advisory committee cited at several meetings the need for students to be well versed in all the civil engineering specialty areas including transportation, while members of the Georgia Section of ITE openly wondered why undergraduate students were not given more exposure to transportation engineering as a career path. There was a concern that the confinement of transportation engineering studies to the graduate level will and is stifling the development of future transportation professionals.

The Challenges to Change:

As a result of the expressed need for more transportation engineering education in the undergraduate curriculum, an investigation was conducted as to the challenges which must be faced in order to implement any changes and the shifting of paradigms. These challenges which were each faced and overcome at SPSU can be expected at other schools as well. Changing the direction of undergraduate civil engineering education at an institution is not an easy task and the faculty who wish to pursue such a course of action are wise to critically examine the resistance to change and decide if the effort needed to overcome the obstacles is warranted. At SPSU, the strong support of alumni, industry, and other faculty in and out of the department prompted this writer to take action and seek to bring about a dramatic increase in the transportation engineering portion of the curriculum.

The resistance to change and the challenges to be overcome fell into two broad categories. The first category identified challenges unique to the specific institution, in this case

SPSU. The second category identified those challenges facing all institutions when seeking to establish or modify an undergraduate program and which in some cases may be caused by the profession itself. With attention to details and focused efforts both sets of challenges proved surmountable.

A challenge, as used here, is simply a nicer way of saying opposition. Opposition to change is human nature and changing the traditional civil engineering curriculum to include a relatively large portion of transportation engineering is a significant change. Because of this, opposition to inclusion of transportation education came from educators at SPSU. These educators used several reasons to justify their opposition; justifications which others may find at their universities as well.

First, it was stated that the curriculum was full and did not have room for additional courses. At SPSU and throughout Georgia universities the general education portion of the curriculum has continually increased to where it represents more than 50 percent of a 4 year baccalaureate degree program. Combined with a change from the quarter system to the semester system and a requirement that all 4 year degree programs have a maximum of 120 semester hours, 128 hours for engineering and technology programs, the curriculum continues to be stressed and indeed has little room for expansion. For every additional course incorporated into the program, one must be eliminated.

This source of opposition proved the most difficult to overcome since it is by definition the classic 'turf war'. With faculty representing different specialty areas, each person has a vested interest in keeping his/her portion of the curriculum in tact or expanding. However, it was extremely difficult for those opposed to change to dispute the need for the proposed curriculum changes given the ongoing survey results of alumni and industry. It is suspected that similar results are to be found in other geographical regions and the need for more transportation engineering at the undergraduate level is much greater than realized.

Second, some educators opposed addition of transportation education because they defined it as 'soft' engineering and not engineering science. These educators had very limited exposure to the transportation field other than a multi-modal broad brush overview course at the undergraduate level which they found uninteresting. Combating this opposition became a matter of educating the educator in the ways of such things as highway design, traffic flow theory, transportation systems planning, and signal design. Once accomplished this opposition significantly decreased. The result of this effort has strengthened this writer's conclusion that the civil engineering curriculum model of the 1950's which has been used with little change other than that caused by the incorporation of the general education requirements, is not applicable today. It must be changed to include transportation engineering as a significant part of the program.

The second category of opposition includes those areas which have developed over the years and which may be present at most institutions. First, the broadening of the field of transportation engineering from highway engineering in the 1950's to the intelligent transportation systems of today and the associated explosion of the body of knowledge in the field makes determination of what is or is not appropriate at the undergraduate level difficult at

best. The old curriculum model used at many colleges and universities provides one ‘overview’ course in transportation in which the instructor is expected to generate interest in the field and provide a synopsis of this vast new body of knowledge known as transportation engineering. This task often falls to an instructor whose specialty area is something other than transportation engineering. Little interest or knowledge other than what is in the chosen text is brought to the classroom. Students, in turn, receive the message loud and clear whether intentionally or unintentionally that transportation engineering is neither interesting nor a worthwhile career path. This is further supported when the student looks for technical electives and finds few if any in transportation engineering.

Second, in higher education today, even with the awareness that more attention needs to be given to teaching skills and preparation of the undergraduate, the reward system for faculty is largely based on research and publications. As a result, in order to succeed at their tenure and promotion endeavors, faculty naturally focus on graduate programs and the associated research and publication opportunities. Working in a system which bases advancement on the ability to attract research and publish, little incentive exists for faculty to promote transportation engineering as an undergraduate experience.

At SPSU all of the aforementioned challenges were present and needed to be overcome. Most prevalent and difficult to address was the notion that the 50's curriculum model had worked so well for so long that no change was needed. As stated education of the faculty in the field of transportation engineering and receptive and supportive department heads proved critical in bringing about the needed changes.

The Undergraduate Transportation Engineering Experience:

As will be shown, the transportation engineering emphasis at SPSU has changed from one required 4 quarter hour course in highway design taught by part time faculty in 1990 to a much more comprehensive treatment of the area. It is this writer's opinion that the changes which have been incorporated into the curriculum at SPSU are the changes with which all civil engineering programs should employ to incorporate transportation engineering as a significant part of the undergraduate engineering curriculum.

The transportation engineering emphasis at SPSU is part of the civil engineering technology program housed in the civil engineering technology (CET) department. The CET department is somewhat unique in that it produces graduates who are as successful as the majority of the nation's civil engineering graduates at passing the fundamentals of engineering exam known to some as the E.I.T.. Graduates earn a TAC/ABET accredited 4 year Bachelor of Science degree in civil engineering technology. Those wishing to carry on their studies at the graduate level are required to attend another school since SPSU does not offer graduate civil engineering or civil engineering technology programs.

With respect to transportation, all students are currently required to take a course entitled “Introduction to Transportation Systems” which is a 4 semester hour course with 3 hours of lecture and 3 hours of lab scheduled each week. This course attempts to generate interest in transportation engineering through the use of the step by step approach to the analysis and design

of roadways, traffic analysis including capacity analysis, and the basics of transportation planning. Laboratory sessions involve students collecting and analyzing typical traffic data in adherence to accepted standard practices. The objective of this course is to provide the student who would otherwise not have any other transportation engineering education to take away from the classroom useful information and methodologies which can make them productive in the workplace. Emphasis is given to dealing with real world analysis and design situations.

This course was developed to replace the broad brush course typical of undergraduate transportation courses. To quote Mannerling in the Preface to *PRINCIPLES OF HIGHWAY ENGINEERING AND TRAFFIC ANALYSIS*, J. Wiley, New York 1998, "...students are learning the fundamentals needed to undertake upper-level transportation courses, enter transportation employment with a basic knowledge of highway engineering and traffic analysis, and answer transportation-related questions on the civil engineering professional registration exam." To accomplish all of this, an analysis/design sequence of two or more courses would be more beneficial than the one course now required. One of the next steps in the development of transportation engineering education at SPSU is to seek a second required course and expand on the foundation laid by the first.

Upper-level elective transportation courses currently offered include Transportation Network Design, Highway Design, Pavement Design and Maintenance, and Special Topics in Transportation Engineering. All of these technical electives are 4 semester hours and include a laboratory component. The lab portion of the course is used for design problems as well as typical data collection and analysis exercises. With 12 semester hours of technical elective required for graduation it is possible for students to graduate with 16 semester hours of transportation courses.

All of the aforementioned courses include topics normally found in the traditional graduate course of similar title but differ in the depth of treatment of the material. Graduate education is unique in that it relies on the achieved technical expertise and maturity of the graduate student to extend the boundaries of learning beyond the traditional limits. At the undergraduate level, students are gaining the technical expertise and progressing toward the maturity level of their graduate counterparts. It is unfair and usually unsuccessful to simply teach the same graduate course to undergraduates without recognition of these differences.

Course Development and Outcomes Assessment:

At SPSU these differences are recognized and incorporated into the course development phase through the use of learning outcomes and consequently outcomes assessment. The first step in the process is the identification of the objectives of the curriculum. Simply stated, this is what the faculty want the graduates to be able to do upon graduation. The objectives relating to transportation engineering education at SPSU closely follow Mannerling's statement previously cited. The three primary objectives are: a. To gain a basic knowledge and understanding of highway engineering and traffic analysis; b. To successfully answer transportation-related questions on the civil engineering professional registration exam; c. To obtain a thorough understanding of the fundamentals needed to undertake graduate transportation course work.

The first two objectives are for all graduates while the third pertains only to those choosing to focus on transportation engineering.

These three primary objectives are then used when developing courses. Transportation courses were developed by first identifying which of the objectives were to be served by the course. In some cases all three were identified. Development of the course then followed by stating the learning outcomes for the course. Again, these are similar to the objectives in that they list those skills and activities which the student should be able to do upon completion of the course. For example, in the required transportation systems course a learning outcome is to be able to identify the level of service on a basic freeway segment. By listing of the learning outcomes, required course content becomes obvious and the specifics of what should and should not be included are identified.

The learning outcomes approach to curriculum and course development is not new but has been used in some form or another for many years. However, its present day benefits to engineering course development include a dovetailing with the new EAC/TAC performance based accreditation criteria which relies on the university to identify their curriculum objectives and assess how those objectives are being satisfied. It is this writer's speculation that the new criteria will force universities locked into the 1950's curriculum model to re-evaluate from ground zero and identify what is and is not important in undergraduate civil engineering education. This effort cannot help but bring focus on the need for more transportation engineering education at the undergraduate level.

Summary:

As a major provider of technology education in Georgia, SPSU has been fortunate in that the CET department with over 250 students and 10 full-time faculty has been able to respond to the identified need for more transportation engineering undergraduate education. Combining one full time transportation faculty with others of diverse backgrounds, the department has been able to increase the transportation offerings, enhance the undergraduate experience, and respond to surveyed industry and alumni needs. The response by the student body has been promising. As of this writing, the SPSU ITE student chapter is the second largest in the world and enrollment in transportation technical electives, an often used measurement of the interest of students in a specialty area, is high and increasing. Others are encouraged to assess the needs of their region, consult with industry and respond to the need for more undergraduate transportation education. The time to put the 1950's curriculum model aside is now.

About the Author:

Thomas R. Currin is Professor of Transportation in the civil engineering technology department at Southern Polytechnic State University in Marietta, Georgia. Dr. Currin has over 25 years of experience in transportation engineering equally divided between private consulting and university teaching. He earned his B.S.C.E. at University of Massachusetts-Dartmouth, Master's at North Carolina State University, and Ph.D. at University of Connecticut. His latest work entitled, "Introduction to Traffic Engineering: A Manual for Data Collection and Analysis" will be available from Brooks/Cole Publishing in Spring 2001.