Engineer in Residence: A Strategy for Increasing Relevance in Transportation Education

Daniel Pritchard and Edward A. Beimborn, Center for Urban Transportation Studies, University of Wisconsin-Milwaukee.

Daniel P. Pritchard, Department of Civil Engineering, Engineering and Mathematical Sciences Building, Rm. E338, University of Wisconsin–Milwaukee, PO Box 784, Milwaukee, WI, 53201-0784, telephone (414) 229-5167, fax: (414) 229-6958, e-mail: danielp@uwm.edu.

Edward A. Beimborn, Professor, University of Wisconsin–Milwaukee, Center for Urban Transportation Studies, PO Box 784, Milwaukee, WI 53201-0784, telephone (414) 229-4978, fax: (414) 229-6958, e-mail: beimborn@uwm.edu.

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Abstract: The paper reports the results of the implementation of an Engineer in Residence concept in the Department of Civil Engineering and Mechanics at the University of Wisconsin-Milwaukee College of Engineering and Applied Science. The Engineer in Residence concept brings an experienced practitioner to campus specifically to mentor students and faculty in the application of engineering and management principles to real-life problems and bring additional relevancy to the educational process. Success of the concept is measured by evaluation completed by students and faculty. Based on the findings of these evaluations, the concept will be continued and expanded.
Introduction

The pace of change in all aspects of transportation has become rapid. Changes are occurring in technology, economic conditions, resource availability, growth patterns, life styles, institutions and other areas, all of which will have profound effects on the future practice of transportation professionals. Transportation professionals of the future will need to be a highly adaptable group that can quickly respond to change and have the capability of dealing with a broad spectrum of problems and issues. Yet while these changes are occurring, education in transportation often lacks a broad based, real world orientation. Relevancy in transportation education seems to be lacking and it appears more and more difficult for universities to remain in touch with the people who hire their graduates or use their research.

There are several reasons for a lack of relevancy in transportation education. A high emphasis has been placed at universities upon extramural funding of research and scholarly publication. Nearly all new faculty enter engineering colleges directly from Ph.D. programs with a background of basic research and limited real world experience. Few, if any, mechanisms exist for bringing in people with extensive professional experience to participate in the education of young engineers. A lack of relevance can lead to many problems. Basic research is done by pretending that it is applied. Applied research is done without ever talking to the people who will apply it. Students are taught to do things their instructors have never done themselves. Reports are written that no one can read or understand, and time is divided into so many little pieces that nothing can ever be done completely or well. Relevancy to real world transportation problems has been lost at a time when it could not be more important.

This paper will explore ways to increase relevancy in transportation education. This will include a discussion of student attitudes towards relevancy and practice-oriented education and a description of an Engineer in Residence program at the College of Engineering and Applied Science at the University of Wisconsin–Milwaukee (UWM) to meet these needs. The paper will describe these efforts as well as the lessons learned from the process so that it may be applied elsewhere.

Student Attitudes

More than ten years ago, a survey was been distributed to senior civil engineering students in transportation that asked them their perceptions of the relative importance of fifteen different course attributes. These attributes include course relevancy, instructor capabilities, comfort factors and course administration (exams, textbook, etc.). Students were asked to rate the level of importance on a scale of 1 to 5 with 5 representing the term "very important", 3 representing "neutral" and 1 representing "very unimportant." The results of these surveys are indicated in table 1.

The two factors rated as most important by students in all cases were "use of practical examples" and "material is relevant to my future career." Both of these were rated near the top ("very important") portion of the scale. Other factors, "having an instructor with practical experience," "a good textbook," "homework is corrected" and "convenient schedule" were rated between "important" and "very important." The remaining factors such as class size, room comfort, frequency of exams, field trips and use of slides and films that primarily relate to how courses are administered were rated from "neutral" to "important." The results were fairly consistent over the three years in which the survey was used.

A follow-up survey was conducted in the fall of 2002 to see if attitudes have changed. A comparison of the two surveys is shown in figure 1. In general, student attitudes of today are very similar to those of ten to fifteen years ago. If anything, students are even more concerned about relevancy and practical orientation than they were in the past. In both time periods, "material is relevant to my future career," "use of practical examples," and "instructor with practical experience" ranked as the most important factors. Students this year placed somewhat more emphasis on small class size, convenient schedule, and use of computers and less emphasis on a good text book and frequent exams than in the past.

These results seem to clearly indicate that students place a high degree of importance to the relevancy and practicality of their education, i.e. its professional content, rather than how they receive the material. Thus efforts to increase the relevancy and practicality of a course would have a greater payoff in the eyes of the students than efforts to provide better administration. Discussions with practicing civil engineers and the people who hire our graduates have shown agreement with the feelings of our students. Experience in engineering practice is highly valued by potential employers even if only in a classroom situation. Teamwork, communications skills, the ability to deal with people, and environmental and global awareness are all characteristics that are highly sought after.
There appears to be a need to develop mechanisms to bring practice-oriented education into our curricula without a major sacrifice in technical content.

**Engineer in Residence Concept**

For a number of years, an Engineer in Residence program was proposed in the College of Engineering and Applied Science at the University of Wisconsin–Milwaukee (UWM) as a way to improve the relevancy and real world orientation for programs in civil engineering and transportation. The concept of an Engineer in Residence is meant to be similar to a poet-in-residence or artist-in-residence program as used in other parts of the university. Efforts would be made to recruit senior engineers with substantial experience in professional practice to spend time on campus as an Engineer in Residence. It is expected this person would have close contact with students through student organizations and participate in design-related components of the curriculum. The person could have responsibility for individual courses such as Senior Design or courses related to engineering project management, and could also work with regular faculty in courses by giving individual lectures and project supervision in other courses. In addition, the person could act as a mentor and advisor to students by assisting them in making career plans and choices. The concept of Engineer in Residence was proposed to substantially improve the quality and relevance of engineering education at UWM.

The concept was met with mild enthusiasm. While most faculty and administrators at the university agreed with the concept, it was always placed at a lower priority than other hiring or replacement of faculty. For many years the concept sat on the back burner, until an event presented itself to implement the idea. Several factors came together that led to the establishment of the position. These were: 1) the beginning of a Engineering Management graduate program jointly offered with the Business School with a special need for faculty with substantial professional experience, 2) the creation of an active advisory committee for the Department of Civil Engineering in response to ABET requirements and 3) the difficulty in finding good instructors with extensive design experience for a capstone senior design course.

As a result of these factors a person was recruited for this position starting in Fall 2002. This was the recently retired Administrator of the Division of Districts of the Wisconsin Department of Transportation. This individual has extensive experience in the management of engineering projects and the development and implementation of transportation programs in highly complex settings. The initial appointment was as an Adjunct Associate Professor with the duties as described below:

“Teaching responsibilities should include CE 495 – Senior Design, elementary courses in civil engineering such as CE 150 Builders for Civilization and Environment and engineering management courses in the Engineering Management MS program. In addition, provide support for the engineering management master’s program, work cooperatively with the school of Business Administration to help implement the program. Person should have substantial engineering management experience in the real world. The person should have master’s degree experience in engineering or business, preferably both.”

“Other duties may include assistance and advice to new faculty in the college working in soils, pavements, structural engineering, transportation and management. Provide advice to new and continuing faculty for the development of research ideas and funding. Maintain close contact with students through student organizations and participate in design-related components of the curriculum. Work with regular faculty in courses by giving individual lectures and project supervision in other courses. Act as a mentor and advisor to students by assisting them in making career plans and choices.”

The position has led to interesting experiences. The balance of the paper will describe observations from the ‘Engineer in Residence’ and as the lessons learned from the process so that it may be applied elsewhere.

**Engineer in Residence: Observations**

**The environment.** As one would expect, the changes experienced when entering the academic environment from almost any other are significant. However, one constant that can rescue the outsider is the student. The student knows they need to learn what you have to offer and seems to have almost boundless energy when it comes to pulling that last bit of information from you. In many ways, mentoring of the student is automatic and success is assured if it’s allowed to be.

Of the environmental issues encountered, the most fascinating – and probably most dangerous to the newcomer – is an apparent lack of a management context. During the last ten years most organizations, both public and private, have spent untold wealth on the creation, modification and implementation of modern management
structure and techniques. Managers have become accustomed to setting clear goals and evaluating the success of their operations by the value brought by these new techniques. Those issues simply are not as important in the academic environment, and the ability to succeed is simply measured by a different set of standards, perhaps a purer set of “manager metrics.”

Most of the management modifications over the last decade have discussed at length how to measure the success of a manager or that of the management philosophy espoused. Most, if not all, philosophies include in that list some variation of the metric “our success is measured by those serve,” and usually employees are included in that list of those served. However, production and budget issues often skew intentions, and the success of employees becomes, at most, only one of many metrics. In the academic environment the success of the staff (the students) and perhaps grant acquisitions are and probably should be the only real measure of success. At UWM, student evaluations are the only measure of success and eventual continuation of the Engineer in Residence position.

Beyond management concepts there are a number of issues the newcomer is bound to discover. Administrative support is one that comes to mind. Most businesses have designated support for their managers that relieve them from knowing the details of processes and practices necessary to make the office run from day to day. That kind or level of support is not apparent to the newcomer and may not exist in the academic environment. At least it does not exist at the level of most corporations or large agencies. This is probably attributable to the loose confederation of the staff throughout the university as well as the need to emphasize student support through resource allocations. This is frustrating to the newcomer. Networking and asking lots of questions usually gets the newcomer the information needed, although not nearly as efficiently as one would expect in a large institution.

Finally, a major environmental difference one encounters is the “loose confederation” of staff at a university. Most agencies or corporations outside of universities, in their need to improve management, have emphasized the need for team development. The complexities of the environment and the problems faced in transportation agencies have led to new approaches to team development and training and to promote those who function best in multi-disciplinary team settings.

That does not exist in the academic environment. Recognition in the academic environment is a function of individual accomplishment. The best description of what exists in the academic environment is to think of staff as a group of “independent contractors.” As with all independent contractors, their successes are a function of their efforts, and with the exception of the occasional grant or project, not measured by their ability to function in a team environment.

Students vs. Employees. Students behave much like employees, very new employees. The environment of the university in many ways dictates how the mentor reacts to them. While they behave like new employees, there may not be an opportunity to treat them as such. For example:

- New employees have a certain reverence (at least as long as their probation lasts) for the manager simply due to his or her position. Students don’t. They will question, even doubt, your every word. That reverence has to be earned and time is of the essence.
- Managers and employees have a “full time” arrangement. That is, as long as they are on the job the mentor is able to observe, monitor and refine the actions of the employee. The student-teacher relationship has significantly fewer opportunities to perform those functions. The mentor must create those opportunities for them to be successful.
- The time a mentor/manager has to influence their employee is, in many ways, indefinite; the length of the relationship is often a function of its success, both negatively and positively. The time available to the teacher/student is preset, and except in rare cases, not a function of the quality of the relationship. A mentor/teacher must make an effort if the student is to determine it a successful relationship.
- Usually, in the manager-employee relationship, it’s the manager who chooses the employee. For the most part, in the academic environment, it’s the students who choose the teacher.
- New employees, once past the initial stage, want to improve the skills they came to the job with. Students, on the other hand, are looking to learn new skills. The challenge to the mentor/teacher is to work hard at keeping themselves and their message crisp, up to date and interesting.
- Another difference between students and employees is that although students may have demonstrated proficiency as a student, they haven’t demonstrated proficiency in the subject matter the mentor is developing. Employees usually have some proficiency, and the mentoring task is different. The manager-turned-teacher has to remember this subtlety when approaching the student.
Finally, in most manager/employee relationships, evaluation of performance is vague or ongoing. In the teacher/student relationship it is clearly defined and final. That final evaluation is the goal of the student. While that fact gives the teacher a huge advantage, it also places significant responsibility on the teacher, as the evaluation or success/failure of a student has far reaching impacts on that person’s life and self image.

**Evaluation**

The program had three goals:

- Mentoring students
- Mentoring faculty
- Bringing a management perspective to the curriculum

**Mentoring Students**

Only this first goal has measurable results at this time. At the end of each semester students secretly evaluate teachers in all courses at UWM. The information from those evaluations is available for each instructor in the hopes of improving his or her skills. The information presented below is the aggregate information from two questions of the evaluation pertaining to the instructor’s perceived knowledge and how the student perceives the impact of that on his or her career. Specifically:

Q4. How well did the instructor relate the course content to professional practice or fundamentals of the discipline? Three year average (out of a possible score of 5): 3.88/5.00; Spring 2002 result: 4.33/5.00. See Table 2 for more detail.

Q13. Do you feel the course content is relevant to your future studies or career? Three year average: 4.37/5.00; Spring 2002: 4.78/5.00. See Table 3 for more detail.

While this sample is too small to draw any statistically significant conclusions, we believe the trend is consistent with the goal of the program and encourages the continuation. The Spring 2002 ratings of the course are very high for the department and especially high for a new instructor.

**Mentoring Faculty.** As one might expect, a new instructor mentoring existing faculty is a sensitive issue and as such it tends to be done on a demand basis; that is, no formal program has been established thus far. What has been done has fallen into two categories:

- Presenting specific subject matter lectures. The Engineer in Residence is to develop experience-based lectures to help show how course material may be applied. For instance, discussing how the National Environment Policy Act has changed the job and role of the engineer.
- Helping new faculty get familiar with the engineering/construction community. Normally, this has been an effort of arranging meetings of individuals and small groups to discuss needs, wants and professional desires.

It is too early to determine if either of these efforts has been successful. Other opportunities, such as conducting seminars and workshops are currently being explored.

**Bringing a Management Perspective to the Curriculum.** At this point this goal is being accomplished by incorporating a “management perspective” into the courses taught. The “Capstone” course, in particular, allows a great opportunity to bring forth a management perspective both in the lecture series and the conducting of the project. Perhaps further confirmation that students do approximate employees is their common reaction to this subject; they doubt the value of needing to learn management concepts, since they’re going to be engineers!

**Lessons Learned**

So far, the experience of this experiment has been positive, enough so that it is to be continued for the foreseeable future. For those who may wish to explore a similar program here are some lessons learned to make the attempt less arbitrary:
Select the mentor very carefully. There are many managers who aren’t teachers, and many successful engineers and business leaders who simply haven’t the patience to accommodate the student or the arbitrariness of the academic environment.

Select mentors who have real and relevant experience. Students will see through a mentor brought on due to position and reputation but with no relevant experience.

Spend time orienting the new mentor. Be gentle with the new person. The academic environment is foreign and unlike any he or she has ever experienced. Orientation will reduce the probably frustration and confusion he or she will experience.

Develop specific goals for the mentors. They’re probably used to it and the goals will soften the transition. Make sure the other faculty members know, and agree to, these goals and the role of the Engineer in Residence.

Advertise. The new Engineer in Residence ought not have to continually explain their purpose for being on campus. Additionally the advertising will raise interest in the community and increase the chances of a successful relationship.

Look to your entire curriculum for opportunities for faculty and students to interact with your Engineer in Residence. “Story telling” can be an effective education tool and most experienced practitioners have real-life examples of how what you are teaching is accomplished.

Develop opportunities for student mentor interaction outside the classroom. Most universities have student chapters of professional organizations. Making the new EIR a liaison or faculty representative to one or more of these groups will increase his or her opportunity for interaction.

Conclusions

The mechanism discussed in this paper, an Engineer in Residence program, serves to help bring about a more practice-oriented education for transportation students. It provides an awareness of real world problems and a broadening of capabilities for students into topics of problem definition, professionalism, and decision making. Reaction by both students and practicing engineers has been good. Flexibility to a different setting by both the host university and the Engineer in Residence are needed to make the program a success. It is a useful concept that can improve the quality of transportation education and better prepare students for careers as transportation professionals.

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Figure 1 - Student Assessment of Importance of Course Attributes
### TABLE 1

**Student assessment of importance of course attributes**  
*(1 = very unimportant, 5 = very important)*

<table>
<thead>
<tr>
<th>How important are the following to you when you take a course?</th>
<th>Spring, 1987 (N = 25)</th>
<th>Spring, 1988 (N = 26)</th>
<th>Spring, 1989 (N = 33)</th>
<th>3 year Average</th>
<th>Fall 2002</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use of practical examples</td>
<td>4.51</td>
<td>4.76</td>
<td>4.70</td>
<td>4.66</td>
<td>4.75</td>
</tr>
<tr>
<td>Material is relevant to future career</td>
<td>4.43</td>
<td>4.73</td>
<td>4.70</td>
<td>4.62</td>
<td>4.79</td>
</tr>
<tr>
<td>Instructor has practical experience</td>
<td>4.17</td>
<td>4.35</td>
<td>4.64</td>
<td>4.39</td>
<td>4.63</td>
</tr>
<tr>
<td>A good textbook</td>
<td>4.17</td>
<td>4.31</td>
<td>4.67</td>
<td>4.38</td>
<td>3.92</td>
</tr>
<tr>
<td>Homework is corrected</td>
<td>4.35</td>
<td>4.20</td>
<td>4.45</td>
<td>4.33</td>
<td>4.13</td>
</tr>
<tr>
<td>Convenient schedule</td>
<td>3.79</td>
<td>4.38</td>
<td>4.45</td>
<td>4.21</td>
<td>4.58</td>
</tr>
<tr>
<td>Use of computers</td>
<td>3.90</td>
<td>3.76</td>
<td>4.03</td>
<td>3.90</td>
<td>3.75</td>
</tr>
<tr>
<td>Use of projects</td>
<td>3.64</td>
<td>3.31</td>
<td>3.61</td>
<td>3.52</td>
<td>3.83</td>
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<tr>
<td>Comfortable room</td>
<td>3.44</td>
<td>3.27</td>
<td>3.75</td>
<td>3.49</td>
<td>3.42</td>
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<td>Use of guest speakers</td>
<td>3.13</td>
<td>3.60</td>
<td>3.70</td>
<td>3.48</td>
<td>3.42</td>
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<td>Small class size</td>
<td>3.72</td>
<td>3.27</td>
<td>3.35</td>
<td>3.45</td>
<td>3.83</td>
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<tr>
<td>Frequent exams</td>
<td>3.64</td>
<td>3.04</td>
<td>3.27</td>
<td>3.32</td>
<td>2.83</td>
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<tr>
<td>Having lab experience</td>
<td>3.03</td>
<td>3.30</td>
<td>3.53</td>
<td>3.29</td>
<td>3.33</td>
</tr>
<tr>
<td>Use of slides and films</td>
<td>2.85</td>
<td>3.33</td>
<td>3.34</td>
<td>3.17</td>
<td>3.21</td>
</tr>
<tr>
<td>Use of field trips</td>
<td>2.85</td>
<td>2.88</td>
<td>3.18</td>
<td>2.97</td>
<td>3.17</td>
</tr>
<tr>
<td>Average</td>
<td>3.71</td>
<td>3.77</td>
<td>3.96</td>
<td>3.81</td>
<td>3.84</td>
</tr>
</tbody>
</table>

### TABLE 2

**Question 4: How well did the instructor relate the course content to professional practice or fundamentals of the discipline?**

<table>
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<td>I</td>
<td>II</td>
<td>I</td>
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<tr>
<td></td>
<td>3.82</td>
<td>4.5</td>
<td>3.86</td>
</tr>
</tbody>
</table>

### TABLE 3

**Question 13: Do you feel the course content is relevant to your future studies or career?**

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
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<td>I</td>
<td>II</td>
<td>I</td>
</tr>
<tr>
<td></td>
<td>3.2</td>
<td>4.79</td>
<td>4.57</td>
</tr>
</tbody>
</table>
Figure 1: Student Assessment of Importance of Course Attributes

- Frequent exams
- Use of lab trips
- Use of slides and film
- Comfortable room
- Use of computer
- Small class size
- Use of projects
- Average
- A good text book
- Homework is corrected
- Convenient schedule
- Instructor with practical experience
- Use of practical examples
- Material is relevant to my future career

Score, 1=very unimportant, 5=very important

2002 1987-89