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THE ROLE OF ADJUNCT FACULTY IN FUTURE ENGINEERING EDUCATION

Abstract
Adjunct engineering faculty are being utilized to a greater extent in engineering education for a variety of reasons. When utilized properly, they can be a valuable asset to engineering programs in their efforts to prepare future engineers for professional engineering practice. Adjunct faculty from industry typically possess an abundance of real world experiences which can enhance student learning. Recent changes in ABET accreditation criteria and educational initiatives by professional societies like ASCE have provided justification for the use of adjunct faculty to provide a more complete educational experience for engineering students. This paper discusses the use of adjunct faculty in engineering education and provides recommendations regarding adjunct faculty as a way to better prepare future engineers for engineering practice.

Introduction

Engineering and engineering technology programs utilize adjunct or part-time faculty to varying extents and for various reasons. In some cases, adjunct faculty are used short term to help cover courses as a result of full time faculty sabbaticals, leaves of absence, or retirements. In other cases, short term increases in student population may be addressed using adjunct faculty. Some institutions consistently utilize adjunct faculty for courses where full time faculty lack expertise. In all cases, the use of adjunct faculty provides benefits and challenges to the institution, students and adjunct faculty member. In addition to bringing their technical expertise into the engineering classroom, adjunct faculty also bring their understanding and insights on professional engineering practice into the curriculum. This inclusion of professional practice issues into engineering and engineering technology programs helps programs better meet ABET criteria.[1-2] In civil engineering, ASCE's effort to modernize engineering education has resulted in the identification of a "Body of Knowledge"[3] (BOK) necessary to prepare graduates for entry into professional engineering practice with emphasis on developing a sense of true professionalism, leadership, and commitment to lifelong learning. The use of adjunct faculty has been identified as an appropriate way engineering programs can incorporate professional practice issues into the curriculum.[4-6]

Background

In 1986, the Panel on Undergraduate Engineering Education issued a report on *Engineering Education and Practice in the United States: Engineering Undergraduate Education*[7] addressing many of the issues facing the future of engineering education. Two issues addressed were the shortage of engineering faculty and the increasing emphasis on theory and research and the decreasing emphasis on the practice of engineering in the curriculum. In discussing both issues, the use of adjunct faculty was identified as a solution. Utilizing non-tenure track faculty, retirees and adjunct faculty was identified as a way to deal with the shortage of engineering faculty. Adjunct faculty with appropriate

professional experience were also seen as a resource for incorporating practical design experiences into the engineering curriculum. The report went on to recommend the use of *Professors of Professional Practice* to complement the work of regular faculty in preparing engineering graduates for professional careers.

Although these recommendations were not immediately implemented, in the past decade, ASCE has moved forward by adopting Policy 465 [8] and its Body of Knowledge[3] document defining the Academic Prerequisites for Licensure and Professional Practice defining the "necessary depth and breadth of knowledge, skills, and attitudes" required for professional engineering practice in the 21st century. As Policy 465 and the BOK is further refined and implemented, civil engineering educators are debating about who is most qualified to teach the various aspects of the BOK.[9-10] For the professional practice issues and courses in the curriculum stressing design, adjunct faculty from industry are generally viewed as more qualified than many university faculty members because of their practical experience. One recent study[11] found that the emphasis on research and availability of grant money in non-traditional fields related to civil engineering has resulted in some civil engineering programs hiring tenure stream faculty from other fields, or with non-engineering BS degrees. This may well limit their ability to become licensed, and therefore not be best qualified to teach design related courses in civil engineering.

In establishing new criteria for both engineering and engineering technology programs, ABET[1-2] provided more flexibility for faculty backgrounds and credentials. For engineering programs, ABET Criterion 6 states:

> "The overall competence of the faculty may be judged by such factors as education, diversity of backgrounds, engineering experience, teaching effectiveness and experience, ability to communicate, enthusiasm for developing more effective programs, level of scholarship, participation in professional societies, and licensure as Professional Engineers."[1]

For engineering technology programs, ABET Criterion 6 states:

> "Overall competence of the faculty will be evaluated through such factors as formal education, balance of academic experience and professional practice, industrial experience, professional certification, teaching experience, teaching effectiveness, technical currency, scholarly activity, professional society participation, communication skills, extracurricular support for student activities, and similar attributes appropriate to the program educational objectives.
>
> Individual faculty members must have educational backgrounds, industrial experience, professional practice, communication skills, and technologically current knowledge that support the field of instruction and program educational objectives. Collectively, the faculty must be capable of providing students an appropriate breadth of perspective and effective instruction in the use of modern technical and non-technical methodologies in careers appropriate to the program educational objectives."[2]

In both cases, engineering experience, professional practice, industrial experience, and professional licensure or certification are explicitly stated as factors considered in assessing the competence of faculty for a given program. In addition, the criteria for both engineering and engineering technology programs do not explicitly state minimum academic degree requirements for faculty members. Historically, engineering technology faculty were required to have at least a master's degree and a minimum of three years of professional industrial or consulting experience. The new criteria no longer give minimum degree requirements or a minimum amount of experience, but most engineering technology programs still require a minimum number of years of professional experience for their faculty, and many prefer faculty with doctoral degrees and professional licensure.

For engineering programs, minimum degree requirements and amounts of professional engineering experience are not stated. The criteria allow faculty of different academic backgrounds and experience levels to work together in an engineering program, in order to best meet the needs of students and the objectives of the program. Thus, faculty with strong research credentials are appropriate for teaching courses focusing on theoretical engineering fundamentals, while faculty possessing significant design experience are appropriate for teaching design and professional practice courses.

Other Professions and Their Use of Practicing Professionals

In discussing the role of practicing engineers in engineering education, consideration of how other professions, such as law and medicine, utilize practicing professionals in their educational processes is warranted. The American Bar Association[12] (ABA) establishes a set of standards for programs of legal education. Their curriculum requirements given in Standard 302.(b) state:

> "A law school shall offer substantial opportunities for: (1) live-client or other real-life practice experiences, appropriately supervised and designed to encourage reflection by students on their experiences and on the values and responsibilities of the legal profession, and the development of one's ability to assess his or her performance level of competence; …"[12]

In describing the instructional role of faculty, Standard 403(c) states:

> "A law school should include experienced practicing lawyers and judges as teaching resources to enrich the educational program. Appropriate use of practicing lawyers and judges as faculty requires that a law school shall provide them with orientation, guidance, monitoring, and evaluation."[12]

Medical programs are accredited through processes described by the Liaison Committee on Medical Education (LCME), which is the nationally recognized accrediting authority for medical education programs leading to the M.D. degree in U.S. and Canadian medical schools. The LCME report on *Functions and Structure of a Medical School*[13] contains great detail about the interaction between the academic faculty responsibilities and the clinical (i.e. practical) experience part of medical training. Physician training after

premedical preparations is one of the strongest examples of including practicing professionals in the instructional process.

Practicing Professionals in Engineering

The idea of having "professors of professional practice" on the faculty to provide students exposure to real world practice is a reality in other fields and is gradually being adopted in engineering education. An internet search on "professor of the practice" brought up several institutions with "professors of the practice" or "practice professor" titles in a variety of fields. In civil engineering, programs at Duke, Rice, Vanderbilt, and Tufts Universities all have "professors of the practice" listed on their department websites. At Rice University "professors in the practice" are "practitioners appointed for up to three years by the university president at the request of a school. They must possess "substantive industrial or clinical experience" and have "demonstrated leadership in an industrial or clinical setting." Appointments are renewable, and are non-tenure track. Practitioners may attend faculty meetings and receive limited voting rights after two years at Rice."[14]

While it may be ideal to have professional engineers with significant professional design experience on the faculty full-time to teach design and professional practice related courses, the strong focus on research and grant money at many institutions often requires faculty to posses strong research credentials at the expense of significant design experience. As a result, programs may have difficulty meeting ABET criteria regarding faculty experience and design courses. Many institutions use adjunct faculty from industry to teach design and professional practice courses.

Definition of Adjunct Faculty

The definition of adjunct faculty positions varies between different institutions. Historically, adjunct faculty have been part-time faculty, usually, but not always, having a full-time job elsewhere. At most institutions, non-tenure track faculty in full-time positions are considered instructors or lecturers if they are hired on three- to five-year renewable contracts. Visiting positions usually are also full-time, but typically have one- to three-year contracts that are not renewable. Some institutions have titles like "adjunct assistant or associate professor" for full-time adjuncts with considerable experience and educational credentials. Another increasing trend involves institutions using adjunct faculty for on-line distance learning degree programs. In this case adjuncts may not be physically present on campus and may never meet their students in person. Adjuncts used in this capacity are not considered in this paper. For the purposes of this paper, adjuncts are considered part-time faculty who may be also working in industry, retired, or between careers and are teaching their students in person.

Disadvantages of Adjunct Faculty

Although the use of adjunct faculty often benefits student learning, there are concerns as well. Finding appropriately qualified adjuncts may be difficult in certain geographic

locations. Adjuncts working full time in industry may have schedules which conflict with institutional and student schedules. This may include scheduling classes in evenings which are inconsistent with the program's usual class times and planning around work travel requirements that may arise during the course of the semester. Limited office hours and minimal physical presence on campus may limit student interest and effort in the course. Adjuncts that are used to working with qualified peers in industry may have to make significant adjustments to be able to teach struggling or unmotivated students. Depending on institutional resources, grading and other tasks may be required, in addition to class preparation and teaching, such that compensation is less than attractive to potential adjunct faculty.

Best Practices for Utilizing Adjunct Faculty

To overcome some of the shortcomings and problems of using adjunct faculty, engineering departments should work at improving the conditions under which adjunct faculty typically work. Several practices[15 -16] can be used in order to utilize adjunct faculty to their highest potential. These best practices include:

1. Attracting properly qualified adjunct faculty

   Adjunct faculty should be technically qualified to teach the material. When faculty resources are limited by short term overload conditions, some institutions may try to hire adjunct faculty to teach lower level introductory courses such as mechanics, and drawing, etc. Most practicing engineers may be somewhat removed from applying these topics on a regular basis and therefore, not interested in these positions. If they do agree to teach these, they may not do it very well due to lack of current experience. While at large research institutions, graduate students may be utilized in these situations, at undergraduate institutions, it might be best for the full-time faculty to teach these lower level courses and bring in an adjunct faculty member with appropriate expertise to teach an upper division technical course in which they are more interested in teaching.

2. Develop good long term relationships with quality adjunct faculty

   Where adjunct faculty are used in long-term situations, good relationships with adjunct faculty can prevent turnover and lead to a lasting academic partnership.[15] Some examples of well developed relationships between engineering programs and adjunct faculty will now be discussed. In a four-credit construction management course, two hours of lecture and a three hour lab/recitation are taught by a full time faculty member while one hour of lecture is taught by a local attorney with experience in contract and construction law. The course is scheduled to fit into his schedule. This arrangement has been ongoing for over ten years and has been mutually beneficial to both the university and the individual.

   Another case involves an HVAC course taught in a mechanical engineering technology program by two engineers from industry. Here the full-time faculty have

no expertise in this field and the two adjunct faculty enthusiastically team teach the class year after year.

In another case, a formerly tenured faculty member who had left academia for industry and is now retired from industry has returned as an adjunct faculty member in mechanical engineering technology. He teaches six credits per term, and because of his industrial experience, is actively involved in advising senior capstone design projects.

A good working relationship between a full-time tenured faculty member and the engineers at the state transportation agency has resulted in retired engineers from the agency serving as adjunct faculty for specialized technical courses such as Transportation, Highway Surveying and Design, and Pavement Design and Management, while the full time faculty member was on a family medical leave absence.

3. Provide office and administrative support for adjunct faculty

For adjunct faculty to be successful, they need the support of the department.[15] This includes providing office space, telephone, computers, and an email account, as well as staff support. Their teaching schedule may not coincide with the department's regular operating hours, so accommodations may be needed to help meet their photocopying and related needs. In addition, they may have questions regarding department policies regarding issues such as grade recording and posting, test proctoring, field trips, and ABET assessment. They may also need guidance using classroom and computer technology, support for which may not be available if they are teaching in the evening.

4. Provide curricular support and training for adjunct faculty

Curricular support includes providing syllabi and course materials from previous semesters to help them get started. From an accreditation perspective, departments should want to ensure that what is being taught by the adjunct faculty member is consistent with their program outcomes. Therefore, they should be willing to share this material. Additionally, if possible, training and mentoring can help adjunct faculty in their teaching and course management. Adjunct faculty may often be more challenged about issues such as student attendance and behavior issues, teaching and evaluation techniques, and classroom dynamics, than they are about the technical content of the course. Some adjunct faculty may be unfamiliar and uncomfortable using the latest classroom technologies. Others may overuse technology, such as PowerPoint, and not stimulate student interest as they had hoped. Providing some teaching workshops[16] for adjunct faculty and assigning each a mentor can help them adapt to the teaching profession. Welch, Estes, and Considine[16] performed a survey of civil engineering programs to establish what topics should be covered in training adjunct faculty and found that most of the topics recommended were related to course and student management. Adjunct faculty

should be included in annual campus or departmental teaching evaluations. Peers and students should provide feedback on their performance to ensure continued educational quality and improvement. These findings agree with the ABA[12] requirements that institutions provide orientation, guidance, monitoring, and evaluation for experienced practitioners used in educating lawyers.

5. Clearly indicate the course level and student abilities

Depending on their level of education and experience, some adjunct faculty may have difficulty teaching very basic concepts to mediocre students. The full time faculty or assigned mentor should provide guidance on historical student abilities in the course. In one case, an adjunct faculty member with a Ph.D. working at government supported research center was hired to teach strength of materials to sophomore students. His expectations of what the students could achieve were well above the students' abilities and by midterm, exam and course grades suggested that a significant number of students would fail the class. The department head had to discuss with the adjunct faculty member that it would be better slow down on material coverage and make sure the students understand fewer concepts well, rather than go too fast trying to cover all the material but have them understand topics very poorly.

6. Include adjunct faculty in department and university activities

Adjunct faculty, are often thought of as not part of the university community and as such are under valued. A dictionary[17] even defines "adjunct" as "a secondary or nonessential addition." It is important, especially for adjuncts to be considered essential to the department and university. When possible, they should be included on email distributions, and included in department meetings and other gatherings, to the extent they wish to participate. In some cases, adjunct faculty are actively involved in advising student senior project or capstone design courses. In one case, a retired engineer is now a full time adjunct faculty member in civil engineering. His responsibilities within the department include teaching sophomore level mechanics courses where the students first get to know him. He then teaches the senior level capstone design course, based on his years of professional experience. Having previously taught the students helps him connect better with the students as an advisor in the senior capstone design course.

7. Work to increase respect and compensation for adjunct faculty on your campus

The use of adjunct faculty has increased nationwide in higher education institutions.[15, 18] Still, many are underpaid and not respected by their institutions and colleagues in higher education. Since their use is likely to continue and the utilization of qualified adjunct faculty presents a real benefit to engineering education, it is in the best interest of engineering educators to work toward increasing the compensation and stature of adjunct faculty at their institution. In one recent case, a well-qualified Ph.D. student at a major research university was

interested in teaching a hydraulics and hydrology course and two sections of laboratory as an adjunct faculty member at another institution. The compensation for the course and laboratory section, however, did not justify the time involved in preparation, travel and actual teaching, and as a result, the individual had to decline the position.

Insights from Personal Experiences

When discussing the role of adjunct faculty in engineering education, personal experiences provide a sense of reference and add insights that may not be apparent to those who have not shared the experience. In the Civil and Environmental Engineering Department at the University of Pittsburgh, a civil engineer holding B.S., M.S., and Ph.D. degrees with extensive industrial experience in civil engineering materials, solid mechanics and structural engineering is currently a full-time Adjunct Associate Professor. Courses taught include sophomore level courses in engineering mechanics and senior level capstone design. Being full-time, he does not fit the typical definition of an adjunct. His observations, however, are worth sharing. He notes that consistency and coordination between adjunct and research faculty should not be overlooked. Practical material taught by adjuncts should be complimentary and not contradictory to what is taught by research faculty in theory courses. An adjunct implying that theory is unimportant compared to principles used in practice is undermining the educational process. His biggest concern is the low pay afforded adjunct faculty. Those who regularly teach as adjuncts do so as a result of their personal motivation and commitment to their students, and not for the financial benefits.

The second author has also served as an adjunct faculty member in the Civil and Environmental Engineering Department at the University of Pittsburgh and at branch campuses of Penn State in southwestern Pennsylvania. With thirty years experience in transportation engineering, the second author returned to the classroom to teach the undergraduate introductory transportation engineering course for sophomore students at the University of Pittsburgh. The second author had observed that with the completion of the interstate highway system during the 1980s there was decreased student interest in transportation careers. By the year 2000, however, consultants lamented the scarcity of graduates that were qualified to engage in transportation, especially roadway design and transportation systems planning. Interest in structural engineering, especially associated with transportation mega-projects, continued strong, but transportation engineering involves more than structures. The shift in focus has moved toward roadway systems and traffic management, and with the aging highway infrastructure, funding for maintenance, rehabilitation and replacement became the larger issue. The teaching assignment was approached with the idea to create an introductory class that would increase student interest in the world of transportation, including the role transportation plays in economic systems. To that end the thrust of the course was broadened by balancing the curriculum with more equal treatment of systems issues such as traffic management along with application issues such as the basis of signal timing and roadway geometry. The capstone of the course was to be a visit to a nearby transportation facility and students preparation of a short paper about their particular interest in transportation.

One benefit practicing or retired engineers possess as adjuncts is connections with industry necessary for setting up interesting student field trips. When planning field trips, however, be prepared for changing plans. The first field trip arranged was to a navigation lock and dam on the Ohio River managed by the U.S. Army Corps of Engineers. Unfortunately the events of September 11, 2001 occurred, and the lock and dam visit was called off as all Federal facilities were off limits to visitors. A visit to a nearby rail transit facility was substituted for that class. In subsequent years a lock and dam visit was scheduled and took place. The new special security clearances required of students and visitors provide a new dimension to transportation design considerations that the students experience first hand.

Based on experiences from industry, the second author knew the importance good writing skills have in engineering practice. He also witnessed the difficulty experienced by young engineers with writing. As a result, a written paper assignment was meant to not only allow the students to practice their writing skills, but also to allow them to express themselves in their own way on the subject. It also helped the instructor assess their learning of the course material which could be used to make adjustments to the course in the future. The subject of the paper had to be approved by a given deadline, and the papers were due before the end of the term so they could be graded and returned.

Reflecting on the experience of teaching an introductory undergraduate course and enhancing the experience with field trips and report writing was a sobering experience. With sixty to eighty students in every class, the workload was much greater than expected. Reading the students' papers was enjoyment for the better reports, and agony for the poorer reports, which were few, thankfully. Making a subjective assessment of report quality is very difficult when looking at technical merit alone. While perfect English was not the object, clearly conveying the message was.

Experience shows that field trips[19] and writing assignments[20] are effective teaching tools. However, opposition to their use in engineering courses may occasionally occur. Engineering courses with technical content and significant writing assignments can be perceived as working the students too hard for the credits earned. This may come from other faculty as well as from the students themselves. Additionally, many full-time faculty involved in significant research or other activities may have difficulty finding time for arranging field trips and planning and grading writing assignments. Thus adjunct faculty requiring more work from students than full-time research faculty may be penalized on student evaluations and in relationships with the full-time faculty. It is therefore best to understand the work ethic of the students and the culture of the department and plan course content and assignments accordingly.

As for the point of working the students too hard, many engineering schools have been forced to reduce the overall workload of undergraduates by reducing credit requirements for graduation. Department chairs may become the focus of criticism for faculty who work the students too hard on the current credit requirements as they exist, and possibilities of promotion may be affected if not handled in a manner acceptable to the

university administration. Student workload by adjuncts not as familiar with the education process requires development and understanding of expectations by both the adjunct and the department administration to avoid unneeded conflict. Adjuncts trying to cure the problem by assigning and requiring more work may hinder the education process inadvertently. For example, the second author has used a field trip and a written assignment as substitutes for other assignments, rather than add-ons to the base workload.

One thing that the second author found very important in his experience as an adjunct faculty member was taking the time to attend faculty meetings and engage in friendly conversation before and after the meetings. This allowed development of collegiality between the adjunct and full-time faculty members, which helped greatly when dealing with individual student's concerns. The welcome extended by the full-time faculty was much appreciated when they saw someone in their midst that was trying to work with them and understand and improve on ways to help the education process. This collegiality lead to invitations for involvement with other aspects of department activities, such as review panels for student presentations, student talent show judging, and curriculum review committee work. What was most alarmingly true, and will no doubt continue, is that the pay afforded adjunct faculty is minimal at best, meaning that adjunct faculty will continue to be utilized when there is a specific need and there is a willing person that has the interest to engage in the teaching process. The best persons for adjunct positions will come from the ranks of those that truly want to do the job, and will rarely include those that are simply looking for any job that will do.

Conclusions

The use of adjunct faculty in engineering education has been utilized for a variety or reasons at many institutions. Recent changes in accreditation criteria and a renewed focus on the professional nature of engineering practice have helped place the potential benefits of utilizing adjunct faculty from industry into a favorable light at many institutions. Adjunct faculty can provide a major contribution to the future of engineering education by bringing extensive technical experience and professional practice into the classroom. The primary beneficiary of this technical and professional experience will be the graduates and as a result, the future of the engineering profession will benefit as well. To obtain the most benefit from the use of adjunct faculty, institutions must work at implementing the best practices which will optimize the experience for the department, the students and the adjunct faculty member. Experiences using adjunct faculty in engineering education and observations and insights from past adjunct faculty themselves, can serve as a knowledge base by which engineering programs, adjunct faculty, and students can all benefit.

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