

CIVIL ENGINEERING BODY OF KNOWLEDGE FUNDAMENTALS VERSUS PROFICIENCY THE CIVIL ENGINEERING PROFESSION AND IT'S OBLIGATION FOR THE URBAN INFRASTRUCTURE

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Abstract

Civil engineering education should be the primary supplier of engineers to address the engineering needs of the Urban Infrastructure. The Urban Infrastructure (UI) includes the distribution systems for the movement of people, goods and information. In its broadest sense, the infrastructure includes the systems of roadways, water supply, waste disposal, energy distribution (gas and electricity), communication networks (wired and wireless) and myriad subsystems that are necessary to provide a quality environment. The engineer is an essential member of the team of professionals that are responsible for the planning, design, construction and operation of efficient, effective, safe and secure facilities. The Civil Engineering discipline is the appropriate professional arena to meet these needs and civil engineering education is the appropriate educational foundation to prepare students to serve as engineers for the Urban Infrastructure. This paper presents some of the current problems associated with the urban infrastructure and suggests the role civil engineering education could play in addressing the educational requirements necessary for one wishing to “solve” the engineering problems of the urban environment.

Introduction

Should an engineering degree be required for personnel responsible for the planning, design, construction and operation of the facilities integral to the urban infrastructure? For the purposes of this discussion the urban infrastructure includes (but not exclusively) the following components: Transportation facilities (bridges and roadways), energy distribution systems (gas and electric), environmental systems (water, water supply, waste water, waste management), public service facilities (fire, police, health).

This urban infrastructure is essential to the quality of life of those living in the urban environment. The quality of these facilities has a significant bearing on the health, safety, and general welfare of the users. When the health, safety, and welfare of the public are involved, the state through its “police power” requires the certification of those working in these areas. For the

engineering aspects of the urban infrastructure it is the Professional Engineering (PE) license that assures functional, safe, economical and effective facilities.

It is the opinion of the authors that the academic preparation necessary for the engineering jobs in the urban environment is quite varied. Traditionally this has been the domain of the Civil Engineering profession. Unfortunately in recent years the academic requirements for a BS in Civil Engineering in many cases exceeds that required for many of the engineering jobs related to the urban infrastructure. The BS in Engineering (BSE) that is an undesignated engineering degree sometimes referred to as a “General Engineering Degree” is potentially an appropriate degree for many of the engineering positions related to the urban infrastructure. It is the proposal of the authors that the BSE be a degree requirement **within the purview** of Civil Engineering (ASCE).

Historical background

Historically the civil engineering profession has been the source of professionals to meet the needs of the urban infrastructure. Beginning in the 1950s, with the advent of the space age, the preparation of engineers for the urban infrastructure has diminished in favor of the preparation of individuals for more *esoteric* works; those necessary for space exploration, one-of-a-kind structures, such as sky scrapers, long-span suspension bridges etc. We are not suggesting that these are not worthwhile areas for preparation of engineers. Our observation is that the majority of the needs in the urban infrastructure arena are being ignored. One need only look at the transportation agencies of the various states to see the dearth of qualified professionals available for the engineering jobs.

Accreditation

For most of the professional positions in the arena of the urban infrastructure, a professional engineering license is required. The normal route to licensure as a professional engineer begins with an ABET-accredited degree in engineering. It is the opinion of the authors that the engineering degree best suited to the preparation of engineers for the urban infrastructure, from the perspective of accreditation, is the BS in engineering degree (BSE). For a BSE the course requirements in mathematics, science and engineering applications are extremely flexible. This is not the case for the traditional civil, mechanical, and electrical engineering degrees. The traditional requirements for these degrees do not provide for the degree of flexibility in the academic program necessary to address the needs of the modern urban infrastructure. However, there is reluctance on the part of the academy and some of the professional societies to promote the BS in engineering degree as a viable preparation for engineering for the urban infrastructure. For these reasons, the authors would like to proffer that the civil engineering profession through its technical society, ASCE, embrace the responsibility for the preparation of engineers for the urban infrastructure. In essence, that ASCE encompasses the flexibility of the BS in engineering accreditation requirements within the ASCE sphere of the accreditation.

Job market

Modern advances in technology have changed much of the way in which problems of the urban infrastructure are addressed. For example, the computer has revolutionized the control of traffic

in the urban centers. Wireless communication has changed the way gas and electric meters are monitored. But one still needs to control traffic and to determine the consumption of energy for billing purposes. These are just a few examples of how the technology has changed the “how” but not “why” some things are done. Therefore the preparation of professionals to work in the arena of the urban infrastructure requires a new approach to the engineering education for the Urban Infrastructure. A few selected topics with adaptations are presented to illustrate this point.

Example 1: In the field of traffic operations (vehicles), traffic control signals still require traditional colored (green, yellow, and red) lights, but control of these lights is accomplished through the use of solid state electronics. Monitoring of traffic counts historically has been through manual observation and pneumatic counting devices. All of these now can be accomplished with computers and electronic equipment. Therefore it is our opinion that the basic electric circuits course for non-electrical engineering students should be redesigned to focus on current state-of-the-art (SOTA) electronic applications. The preparation in the science courses (in this case physics), should likewise be reviewed so that they adequately prepare students to go immediately into a course in fundamental electronic applications.

Example 2: Historically, environmental concerns of the urban environment were addressed under the heading of sanitary engineering. Today modern environmental issues span the spectrum from clean water supply to waste disposal and the management of solid waste (trash). To adequately prepare the practitioners for these areas requires *hybrid courses* in science. By *hybrid* we mean the selection of relevant topics from the disciplines of physics, chemistry, and biology taught such that a myriad of fundamental courses in each of the sciences is not required prior to their study. For example students should know about e-coli and its relationship to disease (biology), the knowledge of Brownian movement (physical chemistry) and its role in the suspension of solids in waste water treatment, and the disinfectant properties of ultra violet light (physics).

These are just two examples of how the curriculum should change to meet the needs of engineers for the urban infrastructure

Curriculum

As has already been recognized by ASCE, baccalaureate preparation is no longer adequate preparation for professional practice. So too, formal academic preparation for the engineering demands of the urban infrastructure will need study beyond the baccalaureate degree. Our proposal is not to minimize the academic preparation but to make it more flexible and thereby provide an academic preparation inclusive of a broader range of careers for which (we feel) an engineering degree is appropriate.

For example, current engineering programs place much emphasis on advanced mathematics, which is not required for the majority of engineering works in the urban infrastructure. This is not to suggest that advanced mathematics should be trivialized. Rather, mathematics appropriate to an application should be required, with just as much intellectual rigor as would be found in courses of advanced mathematics. The important attribute of an engineer for the urban

infrastructure is his/her professional character. Professional character is not synonymous with mathematical rigor.

Our proposal is to create a curriculum that may be tailored to meet both the broad spectrum of urban needs and career opportunities and the aspirations of individual students. Further it is our opinion that such a curriculum belongs under the “wings” of the Civil Engineering profession as represented by the ASCE. A degree of this sort would provide the broadest opportunity for the largest possible population of students. Study beyond this baccalaureate degree will be warranted depended on the individual’s career path.

The scope of engineering for the urban infrastructure

The scope of engineering for the urban infrastructure is quite varied. It begins in the planning phase. The perspective of the engineering mind is an essential part of the planning process. Engineers and design are traditionally looked at as synonymous. This aspect of engineering is well formulated, but oftentimes lack focus on the needs of the urban arena. The safe and efficient construction of urban works mandates supervision by adequately prepared and licensed engineers. While not as glamorous, an essential aspect of all engineering work is the responsibility for the operation (including maintenance and repair) of engineered facilities. The engineering curriculum we envision would have the flexibility at the baccalaureate level to prepare the students for entry into more specialized studies of these various components.

Conclusion

The very origin of the title Civil Engineering was to distinguish those engineering works of “civil society” from those of the military. The urban infrastructure is the essence of Civil Engineering. Therefore it is right and proper that the academic engineering preparation to meet the myriad of engineering careers in urban society be nurtured by the Civil Engineering profession. To accomplish this objective there must be an accredited program with the flexibility to meet the diverse needs of the urban infrastructure and to match students to these career opportunities.

This proposal opens the door for meaningful careers in the field of engineering for the urban infrastructure for those whose interest and aptitude make them well suited to the engineering tasks essential in the service of the urban environment. In addition, it would enhance both the number and quality of persons working in this arena.

This proposal has a dual positive outcome:

- 1- To increase the number and quality of personnel for engineering jobs regarding the urban infrastructure.
- 2- To open the door for meaningful careers in the field of engineering for those whose interest and aptitude lend them well suited to these essential careers in the service of the urban environment.

Reference

*ASCE, Civil Engineering Body of Knowledge for the 21st Century, Preparing the Civil Engineer for the Future
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