Authority In Engineering Education

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ABSTRACT

Authority as a philosophical concept is defined both in general and as it applies to engineering education. Authority is shown to be a good and necessary part of social structures, in contrast to some cultural trends that regard it as an unnecessary and outmoded evil. Technical, educational, and organizational authority in their normal functions in engineering education are described, and challenges to these types of authority in the form of laws, accreditation changes, and the rise of the discipline of engineering education research are detailed. The principle of subsidiarity (basically, devolution of authority to the lowest feasible level) is applied to the issue of authority in engineering education organizations.

Keywords: Authority; Engineering Education; Philosophy; Subsidiarity; Accreditation; ABET

INTRODUCTION

Authority is a concept that has come under suspicion in many Western cultures. Among the first popular bumper stickers of the student rebellions of the 1960s was one that read "Question Authority."[1] That two-word phrase could serve as a motto for a number of cultural, social, and institutional trends that have prevailed during the last half century. In schools of education and among progressives, any overt attempt to exercise authority is often viewed as old-fashioned at best and downright harmful at worst.

And yet it is difficult to conceive of even a small organization, let alone a whole society, in which no form of legitimate authority functions. This is especially true of organizations that employ engineers to do the manifold projects that engineers do, or to teach engineering students at institutions of higher education. What happens when a society which largely accepts the principle expressed by "Question Authority" tries to deal with an organization devoted to engineering education, where authority is regarded with traditional esteem? The potential then exists for a number of problems to arise which are difficult even to express clearly, let alone to understand or to solve. One reason for the difficulty in dealing with these problems is that few of those involved have given much thought to the philosophical characteristics of properly-exercised authority. Many people tend to confuse authority with its black-sheep cousin, authoritarianism, and end up throwing out the baby of authority with the bathwater of authoritarianism.

In this paper, the concept of authority is developed with the help of insights from philosophy. We show how authority, far from being a disposable relic of the past, forms an essential part of any well-ordered organization or society. We distinguish authority sharply from authoritarianism, and show how authority works in the realm of engineering education. We discuss technical authorities, educational authorities, and organizational authorities, each of which play vital roles in the smooth functioning of a university-level engineering school. We survey a number of challenges to authority in engineering education, and propose observation of the principle of subsidiarity as a way of preserving the proper functioning of authority while accommodating the (mostly) good intentions that motivate such challenges.

[1] An online search for the origin of this quotation failed to unearth a verifiable source, although it has been attributed at various times to both Benjamin Franklin and Timothy Leary.

WHAT IS AUTHORITY?

Yves R. Simon (1903-1961), a political philosopher writing from an Aristotelian and Thomistic perspective, published a number of works in which he addressed the question of authority. The essence of his early thoughts on the subject is contained in his *Nature and Functions of Authority* (Simon, 1948), from which we draw the ideas in the following discussion.

Simon begins by noting that there is a tendency in modern thought to equate liberty with liberation from all authority (Simon, 1948, 5-6). But the two concepts of liberty and authority are not simple opposites, like black and white. This is illustrated if one tries to imagine a society in which everyone acted with perfect liberty, and authority of every kind was abolished. Anarchy and mob rule, armed robbery, and widespread crime of all types in the absence of a police force would be the result, and practically speaking, no one would enjoy their liberty for long (Simon, 1948, 2). Conversely, if one tries to imagine a society where authority was absolute and in which liberty was abolished, things would be pretty miserable as well. No one in such a society could exercise any authority, practically speaking, except perhaps the one person who was in ultimate authority. As Simon puts it, "each of these terms destroys itself at the very moment when it destroys the other term by its excess" (Simon, 1948, 2). Therefore, any real society must allow for some measure of both authority and liberty in order to function.

Simon next addresses the argument that authority is necessary only in those cases for which reasoned persuasion is inadequate: for example, in dealing with children, those who are infirm in mind, and criminals. While authority must be buttressed in some cases by coercion when dealing with individuals in these categories, he shows on the contrary that even in an ideal community composed of persons who are "intelligent and of perfect good will," (Simon, 1948, 15) authority is still needed. The reason is that in order to accomplish goals which involve the cooperation of individuals, someone must be in charge, that is, some person or group must act as an authority. Whether that authority is vested in one individual or in a group of authorized individuals, it must be the case that the community recognizes and acknowledges the agreed-upon authority, so that the community may coordinate its talents for the achievement of goals that can only be accomplished by coordinated action.

Along the way, Simon makes the important point that authority is always exercised ultimately by persons, not by institutions or laws (Simon, 1948, 7). Even though we are used to dealing with legal entities with "authority" in the title (e. g. the New York City Port Authority), in practice such authorities exercise their powers through the actions of individuals, whether singly or in a group such as a governing board. The fact that Simon views authority as invariably personal has important implications for the way authority structures are organized, as we shall see below.

After these preliminaries, Simon defines the essential function of authority succinctly: "to assure the unity of action of a united multitude" (Simon, 1948, 17). Authority, properly exercised, serves to coordinate the work of intelligent persons of good will, and those who are under authority freely acknowledge and obey those who rightfully exercise authority. Therefore, those who hope for indefinite progress in which authority gradually decays away as society becomes more rational and reasonable until we reach an ideal authority-less future, are bound to be disappointed. Even an ideal society of perfectly rational and reasonable people would need authorities to coordinate and unite its activities.

Simon's main themes on authority are expanded and elaborated by Victor L. Austin, who has written a book (*Up With Authority*) in which he analyzes and defends the role of authority in various contemporary social structures (Austin, 2010). Austin uses the analogy of a symphony orchestra to illustrate ordinate authority in action. While an orchestra may consist of individual members who are outstanding and talented oboists, violinists, or percussionists, the best any individual performer can do is much less than what the entire orchestra can accomplish under the direction of a good conductor (Austin, 2010, 16-18). While playing Beethoven's Fifth Symphony, the members of the orchestra voluntarily put themselves under the authority of the conductor in order to achieve together what they could not hope to achieve individually. Even though there are some orchestras that manage to do without conductors, such as the Orpheus Chamber Orchestra (Kozinn, 1982), the 15-member Orpheus has a five-member executive board that selects works to perform and in other ways acts as the group's governing authority.

Austin is not alone in making the distinction between authority and authoritarianism. Austin is joined by psychologist Eugene Kennedy and medical doctor Sara Charles, who agree with him that authoritarianism is essentially coercive, using physical force or its institutional equivalents to compel obedience (Kennedy, 1997, 4-5). Authoritarian regimes such as Nazi Germany or the old Soviet Union justly gave authoritarianism a bad name, but the opprobrium sometimes spreads to the concept of authority in general. Authoritarianism moves a society or organization far in the direction of the complete abolition of liberty, and consequently also tends to abolish all authority other than that of the supreme leader or leaders. But Austin takes Kennedy and Charles to task for imagining that political authority as such is inevitably authoritarian. Austin claims, along with Simon, that even in an ideal world, we could not do without duly-constituted political authority. Austin agrees with Simon that authority is sometimes coupled with coercion when it performs a "substitutionary" role; that is, when the subjects of authority are incapable of self-government for various reasons (such as the children, mentally disabled, and criminals mentioned above) (Austin, 2010, 15). But even in its substitutionary role, authority is to be distinguished from authoritarianism, which is nothing more than tyranny wearing a mask of legitimate authority.

In sum, not all authority is equivalent to authoritarianism, which is the unjust arrogation of power by tyrannical means. Authority takes the form of commands issued by authorities (always persons) and followed voluntarily by those under authority. Although authority may sometimes make use of coercion in dealing with those who cannot govern themselves adequately, in a society of mature persons of good will, authority has no need to use force or coercive measures. However, authority is still needed to coordinate and unite individuals in order to foster their flourishing in the achievement of good works as individual parts of the organization or society under authority.

TYPES OF AUTHORITY IN ENGINEERING EDUCATION

Now that we have laid out a philosophically sound foundation for the understanding of properly-constituted authority, we will survey three important ways in which authority is routinely exercised in engineering education. The first way is technical authority.

Technical Authority

The great knowledge base of engineering science is known to students and practitioners largely through the medium of what Austin terms "epistemic authority" (Austin, 2010, 45), meaning authorities who know things and to whom others look for that knowledge. Technical textbooks, lectures on technical topics, and even the tacit knowledge (Polanyi, 1958, 69-245) that is not written down or spoken anywhere, but is nevertheless conveyed through shared experiences such as laboratory exercises and engineering design projects, all draw upon technical authorities in the forms of textbook authors, lecturers, laboratory instructors, and project advisors. Most of what engineers know initially after graduation, they learn not directly by personal experience, but from trusting in and learning from technical authorities.

In this regard, Austin makes the interesting point that all those who act as authorities are themselves under authority. No textbook author ever originates 100% of the information in his or her textbook from scratch. Instead, technical authorities cite other technical authorities, and in turn are cited by others—an example of a general rule Austin proposes: all human authorities are also under the authority of someone else (Austin, 2010, 19). In a particular technical field, microwave engineering for example, one important group authority might be a technical society such as the IEEE Microwave Theory and Techniques Society. But in keeping with the principle that all authority is ultimately personal, the Society itself is composed of its members, some of whom are particularly well-recognized authorities in certain technical sub-specialties. And so it goes for every technical field in engineering: in order to learn about the field, one must recognize and accept the "commands" (in the form of technical information) given by recognized technical authorities in that field.

This is one of the least controversial aspects of the concept of authority in engineering education. Nearly everyone inside and outside the field of engineering acknowledges that there are such things as technical authorities, and that they know their specialized "stuff" better than anyone else who is not an authority in that field. Of course, such technical authorities can disagree, as anyone who has listened to an argument between a speaker at a technical conference and a heckling critic from the audience must admit. But, fortunately for the field of engineering, there is

a general consensus that the scientific method of observation and the testing of theories by experiment is the best way to arrive at the truth of a contested technical matter. In most but not all cases, such tests can eventually resolve many of the conflicts among technical authorities. Such controversies may be encountered from time to time by engineering graduate students at the forefront of knowledge, where things are not yet established with certainty. But by the time technical knowledge makes it into undergraduate textbooks, it is largely shorn of controversy and its technical authority is universally recognized.

Educational Authority

In the conventional form of engineering education, students enroll in a sequence of courses and are issued grades at the conclusion of those courses. Following satisfactory completion of a prescribed body of coursework, the engineering students then receive a degree in a given field of engineering. Along the way, students voluntarily put themselves under the educational authorities of those who teach the courses for which they receive grades.

A person with educational authority is authorized to establish the content and format of a course or sequence of courses constituting a degree plan, and to determine student grades in such courses based upon the results of examinations and other criteria. This is the usual type of authority exercised by an instructor in a scholastic course of any type, not just in engineering schools. Although experiments with no-grades education have been tried from time to time, the nearly universal practice in engineering education is to allow students to proceed through a curriculum to graduation only upon satisfactory achievement of passing grades in the relevant courses. And in any event, all programs accredited by the U. S. Accreditation Board for Engineering and Technology (ABET) must evaluate student performance in accordance with "Criterion 1. Students" of the Criteria for Accrediting Engineering Programs (ABET, 2012).

The matter of grades is more pertinent to the question of educational authority than the matter of course content for a particular reason. As long as an organization devoted to engineering education ensures that its instructors are sufficiently knowledgeable to act as technical authorities for the students enrolled in their courses, the matter of course content is subsumed under the category of technical authority discussed above. We define educational authority, by contrast, to involve all actions designed to produce a classroom environment favorable to learning. It includes the style and delivery of lectures, the designation of homework and laboratory exercises and other learning experiences as required for the course, and the evaluation of student performance in these experiences for the purposes of assigning a grade to each student.

The issue of educational authority in the sense intended here is addressed in many publications in the educational literature. One example will have to suffice for the purposes of this paper. David Whitman is a journalist who visited six successful inner-city high schools that were turning out minority students with educational accomplishments far greater than the average level (Whitman, 2009). He found that there was a common feature shared by all schools he visited: an explicit emphasis on making teachers "authoritative . . . figures" (Whitman, 2009, 56) not only with regard to frequent academic evaluation and monitoring through tests and grading, but with regard to correcting students' personal behavior: things like shaking hands properly, tucking in shirts, and speaking politely. He says that this paternalistic style runs counter to the anti-authoritarian trend of recent thought in K-12 establishment circles. But he admits that it undeniably works.

The case of students under the authority of an instructor in the engineering classroom is a specific example of a collection of intelligent persons of good will, agreeing to submit themselves to the authority of a particular individual (the instructor) for the united purpose of learning material that will help them become competent engineers. The voluntary nature of such submission is expressed in the fact that students can choose from a variety of courses in a school, and for that matter can select from a variety of majors in a university, and from a variety of universities as well. But once one enrolls in a particular class (and refrains from withdrawing), one has submitted oneself to the authority of the instructor for the duration of the class.

This authority can be challenged, as when a student feels he or she has been graded unfairly. And I have found from personal experience of nearly thirty years in the classroom, that the best way one can lose one's moral authority over students is to do something, or merely appear to do something, that seems unfair or unjust. But when

an instructor exercises authority fairly and designs a classroom experience that allows interested students to flourish in their acquisition of knowledge, educational authority is being properly exercised in the engineering classroom.

Organizational Authority

Organizational authority in engineering education is basically the set of commanders and commands that exist to support the work of engineering education: administrators on up the chain of command from the instructor level to the state board of higher education or board of trustees of a private institution, auxiliary centers of authority such as environmental health and safety departments and personnel departments, and personnel committees within departments, schools, and colleges. As such, it is a specific example of the type of administrative authority discussed by political scientists such as Carl J. Friedrich (Plant, 2011). Once one leaves the classroom, there is an increasingly complex array of administrative structures associated with engineering education at the college level. A special case of organizational authority in engineering education is the organization that accredits engineering programs, which in the case of U. S. engineering education is ABET.

It is hard to imagine a way that effective engineering education could take place on a large scale without at least some organizational authority. Someone must decide who teaches what, who should be hired to teach, and whether their services should be retained once they are hired. Someone must collect tuition and fees and make sure there is enough money to pay for the operations of the school. All these functions require administrators to exercise organizational authority. If administrators view their roles properly, such authority will be exercised solely with a view toward achieving the good of the organization and its members, and not for purely personal gain or other selfish reasons.

As we have seen in the previous discussions of authority, every organizational authority in an institution devoted to engineering education is also under some other authority. This is easy to see in the chain of command, but not so easy to see once the links associated specifically with engineering are left behind. For example, the three types of authority we describe do not operate independently. The president of a university may favor the school of engineering with increased funding or discourage it with budget cuts. These are actions available to her within the purview of her organizational authority. But no president in her right mind would presume to micro-manage the technical content of a particular engineering course based on her superior position in the chain of command. This is because rational administrators acknowledge the existence and importance of technical authority, and admit that only engineers with the proper technical qualifications should exercise technical authority in the classroom. To that extent, even the highest occupants of positions in a university chain of command (those who hold organizational authority) must concede that they are, in effect, under the technical authority of those whose specialized knowledge allows them to teach valid technical content to students.

And speaking more generally, state boards of education are under the authority of legislatures, which are under the authority of the people of the state. Boards of trustees of private institutions must acknowledge the authority of a school's alumni and the opinions and attitudes of the public at large, and in particular, parents whose children are attending the private institution in question. So no administrator operating with organizational authority involved in engineering education properly acts independently, without obligation toward anyone or anything. Such action would constitute the organizational equivalent of tyranny, and while tyrants occasionally establish themselves in educational institutions, it is generally not to the organization's long-term benefit.

Obviously, at the higher levels of a university, organizational authority increasingly takes on the nature of political authority, which is the subject of a separate analysis in Austin's book (Austin, 2010, 67-91). Austin and Simon agree that political authority is a good and necessary thing, in general. Austin cites the ethicist Oliver O'Donovan on the necessity for political authority. Austin says ". . . one could not have a society as a whole without political authority: for that authority is the objective correlate to the freedom of the society as such. As O'Donovan remarks, the only examples we have of depoliticized societies are those in crisis or decay . . . ." (Austin, 2010, 79). By "objective correlate" Austin appears to mean the concrete objects and circumstances necessary for the bringing forth of an intangible good. In this sense, Austin is saying that the existence of political authority is necessary for freedom itself to exist in a society. Without political authority expressed in such forms as police and a standing army for external defense, a country rapidly falls into anarchic chaos, and freedom exists only for the few who dominate by filling the resulting power vacuum with private militias, for example.

It is obvious that a certain minimal amount of organizational structure, with its properly constituted authorities, is needed for the smooth functioning of any institution of higher education, especially one devoted to as complex and resource-intensive an activity as engineering education. In a well-run organization devoted largely, if not exclusively, to engineering education, organizational authority is exerted with the purpose of facilitating the efficient and effective delivery of engineering education to students. Other things being equal, larger organizations should take care not to abuse their organizational authority over smaller organizations or individuals. Instead, decisions affecting groups of individuals should be made at the lowest and most local level feasible, and only those tasks or projects that cannot be accomplished at a local level should be undertaken by higher authorities. This is the principle of "subsidiarity" which originated in 19th-century Catholic social thought (Kohler, 1991, 37-38), and violations of it constitute some of the most notable challenges to authority in engineering education, as we will now discuss.

CHALLENGES TO AUTHORITY IN ENGINEERING EDUCATION

As Austin, Simon, and even Kennedy and Charles all point out, modern Western cultures have a strong tendency to dismiss authority as a waning, outmoded artifact of the authoritarian past. Over the nearly three decades of my teaching career, this tendency has shown itself in certain challenges to the forms that authority in engineering education assumed in earlier times. One anecdote will have to suffice for an example of the nature of authority in engineering education in the past.

One of the most colorful instructors of my undergraduate career at the California Institute of Technology was Prof. Robert V. Langmuir (1912-1993), who was a nephew of the Nobel-Prize-winning industrial researcher Irving Langmuir. Prof. Langmuir was a crusty, no-nonsense man, but not without a sense of humor. During one lecture a question regarding the instructor's authority came up, and Prof. Langmuir related a story about a student (we will call him X) enrolled in one of his classes some years earlier. The student was not doing well, and turned out to be the son of an alumnus who was one of the school's most generous donors. One day, Langmuir found himself called to the office of the provost, who told him that he hoped Student X was not going to fail Prof. Langmuir's class. The language Prof. Langmuir used in response is not printable, but he got the point across that an instructor's classroom was his castle, and no administrator or rich donor was going to tell him how to grade a student in his class.

Prof. Langmuir grew up in a time when the authority of a professor in classroom matters went largely unquestioned by anyone: administrators, donors, or accreditation agencies. But as I will describe below, this authority, as well as the organizational and sometimes even technical authority traditionally exercised in engineering education, has suffered from a number of challenges in recent years. Whether these challenges are all to the good or not is a matter of debate, a debate which I hope to encourage in the remaining part of this essay.

Students with Learning Disabilities

One difference of note between the engineering classroom of, say, 1970, and the engineering classroom of today, is that certain students have the official designation of being learning-disabled. Once a university's office of disability services or equivalent has received credentials in the form of doctor's notes, test results, or other information identifying a particular student as learning-disabled, the student is allowed to request special conditions of instruction. In the majority of cases, these special conditions are not overly burdensome to the instructor, being things like the privilege of taking the test in an extended-time environment, special typefaces or reading assistance on tests, and so on. But the critical point here is that a certain area of authority, namely the discretion of the instructor as to the conditions of instruction, has been ceded in the case of certified learning-disabled students to the authority of the office of disability services.

This process looks more threatening in principle than it has turned out to be in practice, at least in the cases with which I am familiar. An opponent of this process might take the point of view that if a student cannot learn under the reasonable and uniform conditions that the instructor has provided already, the student has no business in the class in the first place. If a learning disability hinders the student from learning engineering material, it may well hinder the student in a future career as well.

This argument has been largely vitiated by examples of people with undiagnosed learning disabilities such as dyslexia, who through extraordinary effort overcame their disabilities without any help and showed that except for the specific disability, they were as capable as anyone else of doing engineering. Besides these counterexamples, two laws were passed in the U. S. which bear directly on the rights of learning-disabled persons to an education that takes their disabilities into account. Section 504 of the Rehabilitation Act of 1973 and the Individuals with Disabilities Education Act (signed into law in 1990) are federal laws which contain specific language about the rights of learning-disabled persons to have reasonable accommodations made to allow for their disabilities. In principle, these measures should be no more objectionable than the ramps and automatic doors mandated by the Americans with Disabilities Act (ADA), except that ADA addresses physical disabilities and the other acts address psychological disabilities.

From the viewpoint of an engineering instructor, the ceding of a small part of educational authority to the personnel in the school's office of disability services is predicated on the trustworthiness of those in authority at that office. Because all properly executed authority is based on the trust extended to that authority by those under it, this process fits within the overall picture of properly constituted authority. Of course, the system of providing special conditions for learning-disabled students could be abused. For example, a student could fake a disability merely to get the privileged conditions allowed for such students, or the office could grant disability status illegitimately to those who in fact have no such disability. Fortunately, cases like these do not seem to arise very often. However, this change in the structure of authority in engineering education is only one of many that have taken place in the last thirty years to attenuate the educational authority of the instructor in the engineering classroom, even though it is apparently a benign one.

Family Educational Rights and Privacy Act (FERPA)

Also passed in the 1970s (1974, to be exact) was the Family Educational Rights and Privacy Act (FERPA), a federal law intended to secure students' access to their grade records and to ensure the privacy of such grades. Before FERPA, it was not an unusual practice for instructors to post grade lists, with the full names of students, at the conclusion of each semester. FERPA made this action a violation of federal law. Exceptions were made for things such as transcripts released to prospective employers, but the release of such records must be explicitly authorized by the student or the student's parents, in some cases.

Prior to FERPA, the discussion or disclosure of a student's grade in public was up to the discretion of the instructor. Most instructors with at least a modicum of good judgment refrained from public discussion of a student's grade, especially if it was poor, simply because it was an uncharitable thing to do. However, praising a student before his or her peers for a good grade was a live option before the enactment of FERPA, but is now technically a violation of federal law as well. Kennedy and Charles (Kennedy, 1997, 17) make the point that as properly constituted authority loses public respect and allegiance, the law often moves in to fill the void left by the ebbing of proper authority. It would take us too far afield to investigate the rationale and history behind FERPA, but the effect has been to prohibit both the practice of posting grades publicly, which was embarrassing to some students, and the practice of praising good students for their grades, which may have been largely salutary. FERPA has undoubtedly improved the privacy of the individual student, who no longer has to be concerned about strangers discovering what he or she made in Calculus 2. But it has also led to the purchase of hundreds of paper shredders and the expense of keeping grade records under security measures more appropriate to banks than to educational institutions.

The point here is not that FERPA was a bad law, or that things were better before FERPA was enacted. It is merely to note that one particular class of activities, that of posting grades, which was formerly under the exclusive educational authority of the instructor, is now under the authority of the instructor as regulated by the federal government, whose laws dictate in fine detail what can and cannot be done with grade records.

ABET and EC 2000

In 2000, ABET adopted a new set of criteria (Engineering Criteria 2000, or EC2000) for the accreditation of engineering programs which moved from the old accounting-based model to a new paradigm of quality control

and continuous improvement. Without abandoning much in the way of accounting-type criteria regarding curriculum content and verifiability that every student has taken the prescribed coursework, ABET added a set of new requirements analogous to the industrial practice of "total quality management" (TQM). These requirements dictate that each program must develop a set of statements saying what it intends to do, and then produce documentary evidence that not only it is doing what it intends to do, but that it is continually monitoring its own progress in meeting these goals and that steps are being taken to improve continuously the quality of instruction.

One important consequence of the adoption of EC2000 is that grades alone are no longer sufficient measures of how well students learn. ABET now requires a set of auxiliary "evaluation instruments" that are analyzed and compiled in parallel with the usual grades that the students receive. All this additional machinery must be in place and running smoothly for a couple of years before a program may apply for accreditation under the new criteria.

ABET appears to have handled the transition to the new system reasonably well and program evaluators (who are volunteer instructors from other engineering schools) by and large apply the new criteria more or less the way that ABET says they will. But we pause to note here that yet again, authority that formerly vested in the engineering instructor alone, namely, the privilege of communicating only with grades how well students are doing and the privilege of using one's own judgment and the judgment of one's peers in evaluating the quality of instruction and the need for improvements therein, has now been circumscribed. In effect, ABET is looking over one's shoulder in the classroom by means of the auxiliary evaluation instruments, which often take the form of samples from tests or other instructional material that was already in place. And one must be careful in presenting this auxiliary data to ABET not to leave individual student names on the records, for fear of violating FERPA!

What is the net effect of EC2000 on technical, educational, and organizational authority in engineering education? Technically, ABET refrains from specifying anything more than broad minimum subject-matter requirements in engineering programs. In other words, ABET does not specify course-level content. It simply asks each program to state what its goals are and to show that the program has met those educational goals. So the influence of EC2000 on technical authority in engineering education has been minimal.

Regarding educational authority, the influence of EC2000 has been more substantial. Instructors must now keep extensive (confidential) records of student work samples, auxiliary evaluation instruments, and other materials. Usually, one or two members of the faculty are designated to spend close to full time overseeing ABET preparations before an accreditation visit, and this is time that cannot be spent in the classroom, and ends up lowering the overall efficiency of instruction. And there is the indefinable but definite sense that one's freedom to teach however and whatever seems to best achieve the program's instructional goals has been compromised by a need to show quantitative evidence that such changes have in fact improved things. But unless one has a degree in education and the specialized knowledge that is increasingly regarded as necessary in order to speak professionally about the process of education, such evidence is sometimes not much better than an educated guess, but a guess that is required by ABET.

To summarize, ABET is a necessary and useful aspect of engineering education. Accreditation ensures that a given engineering program meets publicly accepted and published standards and assures the students of a reasonable quality of instruction. However, it is hard to say whether a point of diminishing returns is approaching when the additional workload and burden of satisfying ABET accreditation requirements vitiates the basic good that accreditation was designed to achieve.

Affirmative-action hiring practices

When the U. S. Civil Rights Act of 1964 was passed, its intention was to bar discrimination in employment on the basis of race and sex. Until that time, it was not illegal, though it was certainly immoral, to refuse to hire a person for a particular job because of the color of their skin. The 1964 Civil Rights Act made it illegal as well.

Regarding the gender of job candidates, for some years after the passage of the act the question of hiring females to be engineering instructors was not a significant issue, because there were very few females in

engineering. Some schools had rules that prohibited women from enrolling in engineering classes, and those with no formal rules against it nevertheless allowed male faculty members to do everything they could to discourage women from majoring in engineering. This is a sordid and regrettable chapter in the history of engineering education, and it deserves to be left behind.

However, few would think justice would be served by passing a law prohibiting men from becoming engineers for the next hundred years or so, as compensation for the first century of the exclusion of women from the profession. The ideal that serves as a motivator for the Civil Rights Act, as well as for the ADA and other such laws, is that anyone—white, black, male, female, handicapped, or not—with the ability and desire to become an engineer (or an engineering educator) should be able to do so, without encountering a barricade due to accidental factors such as race, sex, or disability status.

This ideal is a laudable goal, but misguided attempts to realize it can come into direct conflict with duly constituted authorities in engineering education, depending on how they are implemented. The difficulty, as with all matters having to do with what Aristotle termed prudence, or practical judgment, is to determine in a specific case the provenance of a given decision: that is, was it due to discrimination, which is illegal, or to a genuine and bona-fide judgment of a candidate's qualifications arising from the exertion of the technical, educational, and organizational authority of members of an engineering faculty?

Suppose an engineering department, which has up to now been all male, advertises for a new position. As anyone familiar with university hiring practices knows, the U. S. Equal Employment Opportunity Commission (EEOC) is a federal agency charged with the duty of enforcing the 1964 Civil Rights Act and subsequent laws pertaining to discrimination in employment. The enforcement power of this agency binds the university to follow a number of detailed rules regarding what can and cannot be asked of a candidate (for example, direct questions about a person's age are not allowed, because that would be evidence of potential age discrimination), and what records must be kept regarding rejected candidates, and the details of why they were rejected. Usually there is nothing in this process that completely inhibits or derails a search (although this has happened on occasion), but the additional paperwork burden and reporting requirements keep numerous administrators working full time, and add to the duties of engineering educators charged with the responsibility of serving on search committees.

Suppose our fictional all-male engineering department narrows its choice down to two candidates whose qualifications are nominally equivalent, except for one difference: one is male and the other is female. It is a reasonably sure bet that in such a situation, the search committee that chooses the female will not regret its decision (unless, of course, the candidate turns out to be unsuitable for other reasons). On the other hand, a decision in favor of the male, when a qualified female candidate was available, is liable to incur the wrath (and possibly the countermand) of every administrator from the department chair up to the president of the university.

This is not a criticism of the presence of women in engineering, by any means. Instead, it is an objectively stated example of the way that explicitly political considerations, namely, the goal of less unequal representation of certain minorities and "under-represented groups," intrude into a process that formerly was under the authority of engineering educators alone.

Variations on this theme include "special-opportunity" hires in which administrators tempt engineering departments with funding for additional faculty lines outside the usual budget structure, but only if the hire is a member of an under-represented group. The influence of affirmative-action politics extends to the research field, where government institutions such as the National Science Foundation sponsor special research programs open only to certain groups, such as American Indians or women.

Again, while opinions may differ widely about the justice of these practices, that is not the issue here. My concern is merely to point out the fact that any intrusion, for whatever good or bad reason, into the hiring practices of a group of engineering faculty members that does not involve engineering judgments per se, means that the authority of that group to constitute and perpetuate itself in accordance with its own internal criteria has been diminished.

Professionalization of Engineering Education

A common complaint heard from undergraduates is that Professor So-and-So should have been forced to take a course on how to teach when he was in graduate school. But no such courses are typically required as part of a technical Ph. D. program, although a few schools now require one or more education courses as well as completion of technical courses. What if, for political as well as other reasons, an advanced degree in education as well as in one's technical field begins to be required by institutions of higher learning? If the fears on the part of some about a coming "crash" in higher education are justified (see e. g. Shaw, 2011), and a need is felt to restrict the hiring of new faculty, one can scarcely imagine a better-looking means of achieving this restriction than to require increasing numbers of education hours in a candidate's transcript as well as all the technical education and research qualifications that are currently required.

How would this development affect the educational authority of engineering instructors? In contrast to the present situation, in which the skills of teaching are "picked up on the fly" by those aspiring to be engineering educators, it would then be necessary to pass under the judgment (and authority) of members of the faculty in departments of education before one was allowed loose in the classroom. In other words, a significant amount of classroom authority would be removed from those who presently hold it and devolve upon the authorities in the scholarly fields of engineering education, and in education in general. This establishes a novel relation of authority between two different departments, which could possibly be on the same campus: the department of education would hold authority of a significant kind over instructors in the departments of engineering.

From the viewpoint of departments of education, this development would be all to the good. If they have not discovered new and more effective ways of teaching engineering by now, then they have been wasting their time with engineering education Ph. D.'s, and the spread of such advanced educational knowledge can only lead to the improvement in the quality of engineering education anywhere it is used.

Nevertheless, there seems to be a logical defect somewhere in this line of reasoning. It can be illustrated by a simple example. There were no gasoline-powered automobiles prior to about 1890, because the technical and scientific principles that allowed gas-powered automobiles to be built were not yet known. Scientific and technical progress is objectively cumulative in nature. There really was a time before which no one (excepting God) knew what Maxwell's equations were, because Maxwell had not written them yet. We can point to automobiles, TVs, and the Internet as solid examples of basically beneficial things that absolutely did not exist before a specific time in the past, and were made possible by particular advances in technical and scientific knowledge.

But one looks in vain for an equally striking example of how the rise in educational psychology, or the field of graduate studies in education, has led to a marked and permanent improvement in the delivery of knowledge to students. If one compares the average quality and effectiveness of K-12 education today with the admittedly much different environment of the schools of 1950, it is difficult to see that the vastly larger expenditures today and the fact that today's educators are products of Ph.-D.-holding instructors at institutions that grant Ph. D.s in education, has led to a proportional increase in the quality or efficiency of K-12 education. To push this comparison to an admittedly absurd extreme, if the same scale of advances in computing speed from 1950 to 2000 had also been made in the effectiveness of K-12 education, we could by now replace the entire educational bureaucracy with a single pill that would confer a high-school education on eight-year-olds in 24 hours.

The point here is that education is not engineering. Technical or scientific progress leads to largely objective and quantifiable changes in the built environment. Educational progress, on the other hand, has to do with the incalculable—how well students learn, and what they learn, and how they apply it. Many of the conclusions of educational research are solidly based on valid psychological and psychometric principles that are widely accepted as scientific by practitioners of the art. But education science is a social science, and the social consequences of applying any given novel conclusion of educational research will not be quantifiable in the same absolute and objective sense as the improvement in clock speed of a microprocessor, for example, as the result of a change in manufacturing technology.

Engineers are fond of worst-case scenarios, and to be more specific about the possible dangers of excessive concession of authority to the specialty of engineering education, suppose a fad of the kind that periodically sweeps K-12 education comes to strike engineering education. Through legal enforcement, accreditation requirements, or other means, the fad becomes embedded in the required teaching procedures of all engineering schools. And four years later, the result becomes clear: we have a crop of engineering students on our hands who cannot do engineering. The economic and social consequences of this disaster would be significant.

I do not believe that anything that dire could reasonably happen to engineering education. But to the extent that educational authority is transferred from engineering educators themselves to those trained in educational research and holding advanced degrees in education, and not engineering, the community of engineering educators has ceded authority and extended trust to the educational-research community. If that community does not exercise its newfound authority with care, that trust could be betrayed.

SUBSIDIARITY IN ENGINEERING EDUCATION

Most of the examples of challenges to authority in engineering education amount to violations, or at best ignorance, of a principle called "subsidiarity." Subsidiarity is the idea that larger organizations and institutions in a society should work for the benefit of, and not to the detriment of, smaller institutions and individuals. As a simple example, consider the case of a family and a state-run Child Protective Services agency (CPS). The CPS exists to foster the flourishing and well-being of families. So for example, when a family allows child abuse or other extreme maltreatment of its children, CPS is authorized to intervene to the extent of removing a child from the home and placing it with foster parents. This is for the benefit of the child. But one can easily imagine a "bad" CPS agency which oversteps its authority to the harm of families which are doing well, but which violate some cultural or religious norm, for example. The most blatant commonly known example of such a violation of subsidiarity is the practice in the People's Republic of China of enforced abortions on married women who get pregnant in violation of the "one-child" law. The decision about how many children to have is properly one that belongs with the small institution of the family, and should not be dictated by the larger institution of the state.

Subsidiarity as a principle first became well-known by means of an encyclical, *Quadragesimo Anno*, issued in 1931 by Pope Pius XI. The encyclical was one of several issued since the late 19th century that addressed the lot of the working classes and formed the basis of modern Catholic social thought. However, the principle itself is not explicitly religious in nature and can be defended on purely philosophical grounds. Subsidiarity takes the point of view that, other things being equal, the people in a smaller organization or society will be closer to matters needing regulatory or administrative attention, than will be the agencies or representatives of larger entities such as an entire city, a state, or a nation, and so the local organization should possess as much authority over its own doings as possible. In other contexts, this same process is termed "devolution," although that term also carries connotations of degeneration which make it less preferable than "subsidiarity." Commenting on *Quadragesimo Anno*'s enunciation of the principle of subsidiarity, Thomas C. Kohler says, "Through its emphasis on mediating groups and its insistence on vesting authority in the smallest possible social unit, subsidiarity evinces a nuanced understanding of the character and purpose of human sociability" (Kohler, 1991, 37-38). According to the principle of subsidiarity, unless a larger entity is taking actions that truly support or otherwise promote the good functioning of a smaller entity, the larger entity should leave the smaller entity alone.

With regard to subsidiarity, the various challenges to authority in engineering education listed above differ in their degree of compatibility with the principle. To the extent that participation in engineering education by learning-disabled people is a good thing, the offices of learning disability services have improved the delivery of engineering education, and are basically benign with regard to subsidiarity. The FERPA student-grade-privacy act is ambivalent, in that while guaranteeing privacy is a good thing, the additional administrative burdens to achieve this goal have been drawbacks. While ABET's influence on engineering education is a good thing in principle, its power to require additional non-instructional work on the part of engineering faculty members is a drawback and conflicts with subsidiarity to that extent. The professionalization of engineering education does not directly exert the influence of a single large authority over smaller organizations, although it has the potential to erect roadblocks in the paths of those desiring to become engineering educators in the future. Probably the most direct challenge to the principle of subsidiarity is the manipulation of the hiring process for affirmative-action reasons dictated by law

or federal agencies. Again, the outcome—namely, that more under-represented groups join the ranks of faculty in engineering schools—is a desirable one, but the means adopted are, at a minimum, potentially subject to abuse.

If one imagines two poles or extremes of how engineering education could be organized, the role of subsidiarity becomes clearer. At one pole is a sort of libertarian ideal in which individual educators contract directly with students to teach engineering, with no regulatory or other supervision from larger bureaucracies or accrediting agencies. This is actually close to the way education took place in some medieval universities. At the opposite pole is a completely centralized system in which all engineering education is controlled by a national authority, which dictates everything about subject matter, personnel issues, and anything else pertaining to engineering education. Neither of these poles exist in reality, and most engineering programs fit somewhere along a continuum between them. The effect of subsidiarity is to urge movement from the centralized-authority pole toward the libertarian pole, to the extent that is possible and beneficial to the students. In the challenges to authority in engineering education that we have reviewed, it is fairly clear that in most but not all cases, the effect has been in the opposite direction, toward centralized control and homogenization of the process, or toward the achievement of a national-scale political goal at the price of the loss of local authority.

DISCUSSION

In this paper, the concept of authority in engineering education has been placed on a philosophical basis, and distinguished sharply from authoritarianism. We have shown how authority as discussed herein is a necessary feature of all well-functioning organizations and societies, including the enterprise of engineering education. We have discussed three aspects of authority in engineering education—technical, educational, and organizational—and we showed how each aspect is an essential ingredient of the educational process. Next, we discussed several challenges to what has historically been the nearly undisputed authority of the engineering educator in the classroom. All of these challenges are motivated by good intentions, but many of them take the form of laws, or accreditation regulations that have the effective force of law if a program wishes to remain accredited. The last challenge we addressed is that posed by the development of Ph. D.-level research in engineering education, and the possibility that those without the advantage of such a degree may in the future be regarded as less qualified, or even plainly unqualified, to teach engineering at the college level. It is clear that while authority in its three aspects discussed in this paper (technical, educational, and organizational) is a vital and necessary feature of engineering education, the lines of authority have increased in complexity over the last few decades, and the traditional center of authority in the person of the classroom instructor has had to accommodate numerous challenges of various kinds, mostly from state- or national-level organizations. The principle of subsidiarity cautions against allowing such intrusions into local authority and control without good and necessary reason.

CONCLUSIONS

Many of the challenges to the authority of those who teach engineering at the college or university level have come from regional or national authorities in the form of laws or changes in accreditation requirements. Political authority is a legitimate thing in its proper role. But legal intrusions into the engineering classroom, especially if they emerge from centers of federal authority, usually violate the principle of subsidiarity. While nothing has yet occurred along these lines that has severely damaged the ability of most institutions of higher education to offer engineering programs, the intention of this paper was to draw attention to the principle of authority in engineering education, and how it has been eroded over the last four decades or so in specific ways.

An adage to be borne in mind in this regard is, "The price of liberty is eternal vigilance." Should a genuine threat to the authority of engineering educators arise in the future, the community of engineering educators would first have to recognize it as such. We hope that this paper has, at a minimum, provided some intellectual tools that will help the reader to recognize future challenges to authority in engineering education, and if needed, to do something about them.

AUTHOR INFORMATION

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