AC 2012-4282: AIDING AND ABETING: THE BANKRUPTCY OF OUTCOMES-BASED EDUCATION AS A CHANGE STRATEGY

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<h1 style="text-align:center">Aiding and ABETing: The Bankruptcy of
Outcomes-Based Education as a Change Strategy</h1>

Abstract

ABET's Engineering Criteria (EC) 2000 were widely heralded among engineering education reformers as a harbinger of change. And while historians in the Liberal Education Division reminded us that calls for better communication and consideration of social context were not new in engineering education, many dared to hope that things would be different this time. New engineering programs founded in this era promised a clean slate from which to create models of more balanced curricula. ABET's bean counting formulas had so obviously constrained creativity and stifled reform efforts; surely this shift would provide both flexibility and external incentive to engineering programs to make much needed changes.

A decade later, with most programs having gone through two accreditation cycles under EC 2000, we have seen at best incremental change in the liberal education of students and diversification of the profession. In retrospect, adopting outcomes-based education (OBE) might have raised more red flags, as its problems have been well known to education scholars for some time. Drawing on social theories of education that take a critical view of OBE, this paper shows how ABET's implementation across engineering education reproduces and reinforces a certain social order in the profession and in society, one that continues to resist real change in educational structures, curriculum, and pedagogy.

Within the power structures that exist in engineering education institutions, ABET's Student Outcomes (Criterion 3; commonly known as "a-k") sometimes can be used to justify broadening the curriculum when such efforts come under attack by self-appointed technical rigor police. However, just as often, it constrains what is possible in engineering classrooms through its drive for (certain kinds of) evidence of achievement of specified outcomes, regardless of process. ABET supports students' focus on credentialing to the exclusion of intellectual curiosity, undermining its stated outcome of lifelong learning. That diversity goes unmentioned in the defined Student Outcomes reinforces the invisibility of underrepresented groups and tacitly teaches students to devalue efforts to resist exclusionary or unjust practices in the profession.

The paper will close with some discussion of alternatives to outcomes-based education that might better support change in engineering education.

Introduction – EC 2000

This paper is part of a session that seeks to continue an ongoing conversation about accreditation and liberal education, that has taken many forms over the years, and was most recently taken up by historians at the 2011 ASEE conference.[1] My particular concern here is to bring critiques of outcomes-based education (OBE)[2] from critical scholarship in Education to bear on our own version of OBE in engineering in the U.S. – EC 2000. This is very much a work in progress, drawing on discussions among Liberal Education/Engineering and Society Division members in informal settings over the years, as well as among members of the international Engineering,

Social Justice, and Peace network. It is hoped that through this conversation we might begin to connect what is known about outcomes-based education in other areas to our experience with accreditation in engineering. This is my first articulation of an argument of this sort, one that will no doubt need to be refined in future work.

At the time of its unveiling in 1995, EC 2000 drew criticism from some sectors of engineering education, while others heralded the dawn of a new day that would further engineering education reform and bolster the work of the NSF Engineering Education Coalitions, which sought systemic reform in engineering curricula with an eye toward broadening participation in engineering among women and minorities. Critics seemed to object to the added administrative work associated with assessment, and to various aspects of the outcomes themselves, including vagueness and a sense that the non-technical outcomes would take away time from the technical ones.[3-5]

EC 2000 in fact evolved in part out of the work of the NSF Coalitions; when change proved to be slow, some deans felt that accreditation standards were a major obstacle to the engineering education reform effort, and sought to change ABET standards in a way that would facilitate reform. Industry bolstered this effort with competitiveness arguments, seeking a skill set that included professional skills such as teamwork and communication.[5,6]

Gloria Rogers[4] compared ABET standards before and after EC 2000, mapping non-technical outcomes to their antecedents in previous requirements. This reveals that what really changed is program evaluation, as liberal education requirements had been included previously under the "bean-counting" approach that specified how much time would be allocated to particular topics. The focus on outcomes perhaps opened the door for increased time and attention toward the non-technical outcomes, but this would only be possible in institutions where this was valued and championed – and where the leadership recognized that additional time and attention were needed to correct a deficiency in meeting those outcomes.

Members of the Liberal Education Division seem to have welcomed a shift away from bean-counting and toward a possibility for increased emphasis in areas like communication, ethics, and social context.[7] At the same time, some members offered a healthy dose of skepticism grounded in critical analysis. Martha Wilson,[8] whose work warned of the business paradigm and corporatization of the university undermining the goals of liberal education, summarized the situation succinctly:

> If an institution has a strong liberal arts component, then the ABET criteria will support this strength and perhaps help to lend balance between the liberal and engineering studies. On the other hand, if an institution simply follows the "old" ABET criteria of a half a year of humanities and social science courses, with the minimum depth and breadth requirements, these criteria could serve to maintain the status quo, guiding students to take courses (5 or 6 total) which specifically address each criterion. This latter possibility would undermine the liberal education component of engineering, and impede the attainment of an engineering education which is broad-based. Nevertheless, it could still fall within the ABET guidelines.

Joe Herkert[9] expressed concern that engineering education had up until that time too little focus on non-technical outcomes and argued that the community was ill prepared to implement the ethics-related criteria in particular. Bruce Seely[10] among others pointed out the cyclical history of engineering education reform efforts and an ongoing struggle around the role of liberal education of engineers. The sense that this issue is revisited through time suggests that it will not be solved once and for all with this most recent round of reform.

Now most of our institutions have gone through two cycles of ABET accreditation under EC 2000. What has changed? For those of us concerned about the liberal education of engineers, has student achievement of non-technical outcomes increased? Have their professional and interpersonal skills improved? Or their ability to engage in social and ethical analysis? Do engineering educators teaching in the technical core yet value these educational outcomes? How much of the progress we observe is specifically attributable to OBE?

This paper begins with a theoretical grounding in critical pedagogy, taking up the idea of reproductive education in social theory, and reviewing the work of critical scholars in education who have analyzed OBE. We then will ask what this means for engineering, and consider evidence from the literature to date on the impact of EC 2000. Finally, we consider what this means for the future of engineering education, and what alternatives might take us in a more transformative direction.

Reproductive education

Maralee Mayberry[11] makes a helpful distinction between pedagogies that are inherently "reproductive" of power structures in society, and those that are "resistant" or "transformative." She draws on a rich tradition of critical pedagogy and social theory that examines how educational processes reproduce hierarchies along lines of class, race, gender, and other social identifiers. For example, Antonio Gramsci detailed how educational structures serve the power of the state. He wrote that the state's duty is "to raise the great mass of the population to a particular cultural and moral level, a level (or type) which corresponds to the needs of the productive forces for development, and hence to the interests of the ruling class."[12] Pierre Bourdieu, by contrast, focuses his argument on reproduction of cultural expressions of class. Arguing against the prevailing idea at the time that social differences were vanishing, he

> sought to propose a model of the social mediations and processes which tend, behind the backs of the agents engaged in the school system – teachers, students and their parents – and often *against their will*, to ensure the transmission of cultural capital across generations and to stamp pre-existing differences in inherited cultural capital with a meritocratic seal of academic consecration by virtue of the special symbolic potency of the *title* (credential).[13]

Since the late 1960s education theorists have spoken of a "hidden curriculum,"[14] a term that encapsulates the unspoken lessons imparted by educational systems around compliance with certain social orders. Bowles and Gintis[15] demonstrated how class status is reproduced in

American public schools, despite standard curricula intended to create similar experiences in all schools. Their empirical analysis of census data and measures of intelligence showed meritocracy to be a myth, as IQ did not predict occupational status or socioeconomic mobility.

OBE and its Critics

OBE emerged largely out of the work of Bill Spady, and is something of a pop-educational and political phenomenon.[2,16-19] Spady's work does not lend itself well to a clear definition of OBE, so I will follow Michael Lorenzen's[20] lead in drawing on James Towers:[21] "Education that is outcome-based is a learner-centered, results-oriented system founded on the belief that all individuals can learn." For Towers, OBE has four elements: clearly defined outcomes; achievement based measures; multiple assessment strategies; and sufficient time and assistance supporting student achievement of outcomes. Engineering educators will recognize much of ABET in this description of OBE. It is worth repeating here Lorenzen's comment that, by Towers's own definition, OBE is in fact *not* learner centered, but fundamentally *outcome* centered. Outcomes might or might not be learner centered. And, if Richard Berbach is right that OBE lacks reflexivity,[22] this might not be self-correcting.

Identifying OBE's ideological roots is a bit difficult, but it appears to have some relationship to more well developed concepts in the education literature around mastery,[22,23] and it also owes a heavy debt to Fordism and Taylorism, to corporatization of the university where students become customers, and to positivist epistemologies and a hyper-reliance on evidence for accountability.[22] Discourse analysis has identified a strong influence of corporate jargon in the language of OBE.[22, 24]

Capper and Jamison provide a clear critique of OBE from a critical pedagogy perspective.[23] They identify the orientation of OBE as structural-functionalist; that is, consciously or not, OBE lends itself to educational institutions' aim: socialization of students to perform in the existing social order. This is operationalized through a system of mastery, which Capper and Jamison show to be at odds with learner-centered education. "Success means mastering what people other than the student deem important and performing the mastered material in schools and society as they are currently structured" (p. 439). They further argue that a mastery framing within OBE means that when students fail, it is their fault, not the fault of educational structures, the curriculum, or pedagogies employed, undercutting the "education for all" sentiment expressed by OBE advocates.

In the United States, the large-scale implementation of OBE took the shape of the standards-based "No Child Left Behind Act." It has come under criticism from many viewpoints, with critical pedagogy scholars calling out the reproduction of inequality inherent in NCLB. While the intent of both OBE and NCLB may have been a "level playing field" where all students would have access to the same educational outcomes (causing famous anti-feminist Phyllis Schlafly to rail against OBE[25]), in reality NCLB affords choice to a privileged few while limiting the choices of the rest[26] and serves neoliberal economic interests.[27, 28] Similar critiques have been levied against OBE in South Africa[29, 30] and Australia,[22] though both governments have abandoned or

moved away from OBE in recent years. (Bill Spady has disavowed these large-scale manifestations of OBE as not true to his theory.)

Critical pedagogies like those laid out by bell hooks[31] and others place central importance on classroom relationships. They would question the complete devaluation of the learning process in OBE. In the case of engineering, the move to EC 2000 was concurrent with a movement toward active learning, but it is important to note that EC 2000 did not itself require or even encourage it. Active learning may appear to be the perfect process-focused complement to ABET's outcome focus, but neither EC 2000 nor active learning seeks to change student-teacher power relations,[11] with profound implications for social reproduction as well as achievement in ethical thinking, lifelong learning, and social analysis.

Reproductive Engineering Education

Reproductive educational theories would predict that relationships of power in the profession and in society would be reproduced through engineering education. While each discipline has its own hidden curricula, understanding the particular processes through which engineering maintains its hierarchies can help us know when we might successfully apply resistive strategies from other disciplines, and when we need to find new ways to address reproductive educational practices in engineering.

In engineering it is particularly easy to see evidence of hierarchies being maintained in the over-representation of middle class straight white males in the profession.[32] An important question for engineering education research is exactly *how* this reproduction occurs. Amy Slaton's groundbreaking historical analysis of whiteness in U.S. engineering education reveals the institutional, cultural, political, social and economic forces at play in maintaining engineering as a white profession.[33] She exposes in particular the racial biases inherent in "color blind" meritocratic policies as well as in liberal-minded reform efforts that stop short of real curricular or pedagogical change. Ethnographic and historical studies of masculinity[34-36] similarly have sought to uncover the processes by which gender hierarchies are maintained in engineering classrooms and workplaces.s

New work by Julie Martin's research group at Clemson University investigates the role of social capital in decision-making among under-represented engineering students.[37] Emerging work on the experiences of working class and first generation students may shed some light on how engineering reproduces class.[38] Sexual orientation is even less well studied, but new work suggests that lesbian, gay, and bisexual students face obstacles enforce heteronormativity in engineering.[39] Foor and colleagues employed an ethnographic approach to illustrate how the intersection of race, class and gender affected one student's experiences of engineering, interpreted using the concept of social capital.[40] All of this work points in some ways to structural forces at play in socially reproductive engineering education.

ABET's outcomes reinforce a valuation of product over process in traditional engineering education. Despite strong attention given to process in both problem solving[41] and design[42] in the engineering education literature, and even recognition on a theoretical level that this is a false

dichotomy,[43] traditional educational practices persist that strongly or exclusively value the right answer, or a working prototype.[44] ABET outcomes thus may undermine engineering educators' efforts to foster effective student learning processes.

ABET's lack of attention to process (outside of program administration) also means that engineering education can retain its racist, sexist, militaristic, and cutthroat cultures[45] as long as graduates meet educational outcomes. And while some outcomes might arguably move students toward teamwork, ethical behavior, and better interpersonal skills, it is easy to meet these criteria without producing a cultural transformation within engineering departments themselves – especially when academic institutions exert pressures against such transformation.

A glaring absence in EC 2000 is an outcome related to diversity. This lack of an outcome frames a situation in which we need not discuss difference and privilege, which is itself a privileged position. It reinforces the invisibility of women and minorities, queer students, working-class students, students with disabilities, and non-traditionally aged students. This hidden curriculum tacitly teaches students to devalue efforts toward inclusion and social justice, and to even resist recognizing injustice in their midst. Future engineers learn to ignore their own privilege, or ignore marginalized identities they may themselves possess.[46] All of this lies beneath a surface rhetoric of egalitarianism and meritocracy in engineering. Ultimately it does not matter how we treat each other in the classroom, as long as we meet the outcomes in the end.

What has EC 2000 accomplished?

My own experience in founding a new engineering program after EC 2000 is that the new criteria gave us an opening to justify the development of an innovative program in both pedagogical and curricular terms.[47-50] I know on a day to day basis that what I do in the classroom is a radical departure from how I was taught, and that this has a profound impact on students. Still, the verdict of independent scholars studying our program has been that we are not that different, and our efforts at innovation may not be having their intended effect.[51] Moreover, the structure of accreditation limits change at our institution and in other new and innovative engineering programs.[52]

I have pragmatically used EC 2000 as a motivation or justification for the use of critical pedagogies and for liberal education reforms in the engineering curriculum. At the same time, EC 2000 undercuts some goals of critical pedagogies (and in fact ABET's own lifelong learning outcome) by reinforcing the idea of credentialing as the central purpose of an engineering education. While the drive toward credentialing is found across the university, it holds particular power in engineering. Superficially, one might posit an explanation that undergraduate education leads directly to entry into the profession, thus making credentialing a central concern. But the goodness of fit here may run deeper to underlying relationships of engineering, ABET, and OBE to corporate organizations and neoliberal thought.

The largest study of the impact of EC2000[5] presents a positive case for EC 2000, but the data nonetheless show how engineering education falls short of being fundamentally transformed under this rubric. The study was commissioned by ABET and conducted by the Center for the

Study of Higher Education at Penn State. It looked for changes in students' preparation for the profession (i.e. in attaining outcomes) and for changes in organizational policies and practices (e.g., faculty involvement in assessment, changes in hiring, promotion, and tenure decisions). They collected data from 40 engineering schools offering over 200 engineering programs, surveying over 1200 faculty, 147 chairs, nearly 5500 graduates from 1994 and 4330 graduates from 2004, 39 deans, and 1622 employers.

Chairs and faculty reported changes in curricula. Though few had reduced emphasis on technical material and skills, 75 percent reported "some" or "significant" increases in emphasis on communication, teamwork, use of modern engineering tools, technical writing, lifelong learning and engineering design. I note that engineering ethics is conspicuously absent from this list. More than half of faculty reported "some" or "significant" increases in emphasis on these outcomes in their regular courses. Teaching methods also changed toward more active learning methods, as well as attendance of professional development opportunities to improve teaching, though it is difficult to separate the impact of EC 2000 from the active learning trend in engineering education. Not surprisingly, more faculty were involved in assessment. Half of the chairs and faculty surveyed said the reward system did not change with EC 2000, while 25 percent said there was less emphasis on teaching, and 25 percent said more. Senior faculty were more likely to perceive a stronger emphasis on teaching; untenured faculty, less.

2004 graduates reported more active learning experiences than the 1994 graduates, though differences were small. Disturbingly, the 2004 graduates reported a less welcoming climate for diversity than the class of 1994. The students gave the same evaluations of their instructors' teaching skills, which raises some questions about the effect of the shift to active learning and the additional faculty training. The students' self-evaluations for outcome achievement were significantly higher among the 2004 grads for all outcomes. The study authors attribute the change to an emphasis on foundational knowledge, a shift toward active learning, and more emphasis on assessment. They do not attribute the change to a shift toward the liberal education of engineers. Employer respondents, while viewing the outcomes as important, reported only moderate improvement in teamwork and communication, no change in technical skills, and a modest decline in problem solving skills. "Barely half" found social context to be adequate, and most said that skills declined somewhat in this area.

While the study's authors declare that dramatic changes have occurred, their evidence is rather mixed, and does not support what some engineering educators had hoped for – a real change in emphasis in undergraduate engineering education.

Looking at this another way, we can take up the concerns of Joe Herkert, a Liberal Education Division member interested in engineering ethics concerned that the engineering education community was ill prepared to teach ethics to engineering undergraduates. [9] He supported this claim with evidence for extremely low levels of scholarship on ethics education in the engineering education literature. He reviewed the number of publications in the *Journal of Engineering Education* (*JEE)* related to engineering ethics, and found very few. I sought to update his data (Table 1), and began with an attempt to replicate his counts on the 1996-1999 data. I found I had perhaps narrower criteria than he did in 1999 for what constituted an engineering ethics paper. I required that ethics be the central subject of the paper, normally

included in the title or else in widespread use in the text. The results show no observable difference in ethics papers in *JEE*, except that, remarkably, in six out of the last ten years, there are absolutely no papers on ethics in *JEE*. This can be explained to an extent by the trend in *JEE* toward a narrow definition of "rigorous engineering education research" that emphasized large quantitative studies.[53] I did not consider publications in *Advances in Engineering Education* or other journals. It should be noted that *Science and Engineering Ethics* existed as a specialized journal throughout this entire time period, having been founded in 1995. It should also be noted that the emergence of the Ethics Division within ASEE is a positive development that has created a strong avenue for a large body of scholarship in engineering ethics. It is a disappointment, however, that this work does not appear to be making it into ASEE's flagship journal. This certainly suggests at least one kind of limitation on the change brought about by EC 2000; it may not be the fault of OBE per se.

Table 1. Ethics-Related Papers in the *Journal of Engineering Education,* 1996-1999,[9] replication and updating by Author			
Year	Total Articles Published	Ethics-Related Papers	
		Herkert Original	Author's Count
1996	47	6	2
1997	43	3	1
1998	77	3	2
1999 (to date/total)	20/81	3	3
Total (96-99)	**187/248**	**15**	**6**
2000	71		2
2001	103		3
2002	66		0
2003	59		0
2004	42		0
2005	48		2
2006	39		2
2007	37		0
2008	50		1
2009	37		2
2010	37		0
2011 (3 issues)	27		0
Total (2000 on)	**616**		**12**

With regard to diversity, Sue Rosser concluded early on[54] that EC 2000 would provide limited change at best. Her argument is based in both a critique of the outcomes framework that does not change the climate for women, as well as in shortcomings among the outcomes themselves as compared with her own proposed standards for female-friendly engineering. Hopefully critiques such as hers will gain a new hearing ten years hence as we seek to broaden the range of voices taking a step back to examine the structural frameworks in efforts to change engineering education.

Conclusion: Alternatives

ABET accreditation structures, and in particular their reliance on OBE, constrain the development of curricula and pedagogies that could change engineering education in deep ways, at the level of institutions, and at the level of epistemology. "Continuous [sic] improvement" does not, over years, accumulate to create systemic change, but instead busies faculty in cycles

of corporate speak and mid-management processes that do little more than lend support to neoliberal trends in academia.

It may be premature to begin a conversation about alternatives before the critiques of OBE in engineering education have been fully articulated. Tentatively, then, I will point to some strategies that may address the concerns I have raised here about OBE and EC 2000.

We have learned from critical pedagogy that our apparatuses of university administration and accreditation will reproduce structures of power that we ultimately seek to dismantle, resist, or change. We cannot retain the same decision-making structures – neither in our universities nor in our accreditation system, and expect to see different results. Thus, a project as simple as changing ABET outcomes - for example to include diversity as a new engineering criterion -- will not bring about significant change. Instead, we need to think in more sophisticated ways about structures of power and how we can resist and transform them, even as we are caught up within those structures.

What if we began at the center of OBE and ABET, with the notion of assessment? Our entire notion of assessment would need to be reframed. Here critical pedagogy can be of some help. In critical, feminist, post-colonial, queer, and other forms of resistant pedagogies, those traditionally marginalized are brought center as participants in their education. What would it mean for members of under-represented groups to formulate assessment practices, or for students to be *centrally* involved in their own evaluation? What would it mean if our blue ribbon panels that name directions for engineering education were not a who's who list from the National Academies or the *Fortune* 500, but instead comprised a representation of individuals across American society, and from around the world?

With Ramin Farahmandpur,[55] among other scholars of critical pedagogy, I put forward one proposal of resistance -- for faculty to make the connections between our own labor in the academy and global neoliberalism. If we can first understand how OBE and ABET relate to the corporatization of the university, perhaps we will then be increasingly concerned about global imperialism and engineering's role in it. Perhaps we will be moved to act in solidarity with others around the world resisting free-market fundamentalism. It may not change our own situation immediately, but it may reverse some of the underlying structural problems that are so much more far-reaching than engineering education or the academic sphere.

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