Drowning in Method, Thirsty for Values: A Call for Cultural Inquiry

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Abstract—A decade or more has passed since publication of most calls for reform in engineering education. In the ensuing time, there has been significant work on the design, implementation, and transferability of appropriate methods and techniques – accompanied by, in most cases, little discussion of the values and beliefs of the people involved. But many theories of change rely on a fundamental shift in human beliefs and values, and purport that institutionalization of methods is impossible without this shift. Given this, now may be a reasonable time to revisit the questions: What are the values of people involved in engineering education, and are our educational reform efforts considering these values throughout the curriculum design process? In this paper, we examine several models for engineering educational reform, with a particular focus on the role of individual values in determining responses to change. We highlight the importance of developing understandings of individual perspectives and social context. We contrast a user-oriented approach to curriculum design with common scenarios of curriculum design practice, and we argue that, in many cases, successes in curricular change can be traced to employment of user-centered approaches.

Index Terms - curriculum, educational reform, user-oriented design, values

INTRODUCTION
In the past two decades, engineering educators have witnessed several calls for deep, systemic reform of technical education. Well-known examples include the ASEE Green Report[1] and recent National Academies Engineer of 2020 publications[2]. The agendas and goals for these calls for reform are expressed in terms of meeting the anticipated needs of the new era, and ensuring the “currency and vitality of 21st century engineering education” [2]. The reports make a strong case that there are significant problems in the engineering educational system, and that widespread and substantive change is necessary.

The NAE and ASEE publications prescribe changes in the functioning of our organizations, and they outline different methods, techniques, or activities that may lead to the desired outcomes. In response to the calls, the engineering education community has undertaken significant curricular design, development, and implementation endeavors. These efforts take a variety of forms and occur across a range of scales; and it is not uncommon to learn of reforms that are planned for the course, department, and institutional levels in engineering departments.

The reports present rational arguments in support of strategies aimed at responding to the identified needs. We submit, however, that systemic change requires that educators consider more than innovative activities and teaching methods. We propose an alternative model, summarized as “people-product-politics,” that we believe offers insight into potential approaches for achieving systemic change. It is a model motivated by work in user-oriented design, and it suggests that the key to achieving change is recognizing and responding to the values of the people involved throughout the entire design, development, and implementation process, rather than just post facto. In this paper, we review existing models and examples of curricular design in engineering and medical education, as well as studies of human and social factors that are important to consider in change processes, and argue that a user-oriented approach to curricular design can and has lead to successful curricular change.

CURRICULUM CHANGE IN ENGINEERING EDUCATION
In this section, we briefly describe several change approaches employed by engineering educators, and we note some advantages and challenges associated with each.

The “Just Do It” Model
At the individual course level, curriculum design is generally performed in a highly informal manner, without reference to any mental model of a design process[3]. There are a number of reasons for this. First, most instructors tend to operate under significant time pressures, which results in real-time course changes that occur without an overarching ideology or orientation toward broader impact. Second, instructors often believe they know the answer before they begin – engineering educators have typically thrived in traditional educational settings, and so the natural working assumption is often, “what worked for me should work for my students.” Third, instructors are empowered to make decisions based solely on their individual experiences. Faculty members operate with considerable autonomy and are able to bring their experiences to bear directly on the course they are designing. Finally, when an individual
instructor is designing a course, there is little apparent need or pressure to employ design methodologies. The energy barrier for small-scale experiments is low, and iteration can simply be done on an ad hoc basis.

**The “It’s an Engineering Design Problem” Model**

When a model is used for course or curriculum reform efforts, it tends to be derived from engineering design practices. It has been widely observed by engineering educators that curriculum design is like any other design process, and that we should use what we know as engineers about the design process in designing curricula. This approach tends to mirror product-oriented design models. The process begins with a set of requirements (learning objectives or outcomes) and constraints (class size, faculty resources, budget), and it ends with a set of specifications (teaching methods, assessments, etc.). Typically this approach employs a small, sometimes interdisciplinary, design team that develops and pilots the curriculum, and then works to get the curriculum adopted. If broader impact on the educational community is a factor in the design process, as may be the case when external funding is involved, some emphases may be placed on best practices and transferability of the curriculum to other institutions. Examples of curriculum reform efforts that apply a product-oriented or engineering design process model are found throughout the engineering educational literature [4-6,10].

The language and approaches employed in designing engineering curricula typically echo conventional approaches to engineering design. Everett et al. describe such an approach to the design of an integrated first-year experience [4]. Everett notes that curricular design processes generally focus on answering the questions that Bloom poses [7]: What are the objectives of the course? What learning experiences will lead to attainment of these objectives? How should the experiences be effectively organized for the learner? How can the effectiveness of the experiences be assessed? The process is iterative, and it involves idea generation and selection, applied to identification of the constraints, the high-level vision for the design team, the requirements (outcomes and content), and the learning experiences.

**The Community Approach**

Changes at the program or college level often require an application of formal curricular design approaches with an emphasis on involvement of faculty in the design process. Design processes that involve significant interaction with a large portion of the faculty are commonly seen as a “political” approach, and they reflect the “shared vision” concepts described in organizational change literature [8]. Group participation in innovation efforts can lead to a sense of individual ownership, and ultimately to higher rates of adoption [9]. For example, through weekly discussion of design ideas, the curriculum developers at Rose-Hulman were able to broaden the faculty interest and involvement in the sophomore curriculum design process [10].

The involvement of community members and the application of a formal design process can lead, as expected, to much better designed courses and curricula than ad hoc approaches. It is worth highlighting, though, that this model of curriculum design is still typically highly product-driven. That is, the focus is on the course content and learning outcomes, and there is relatively little mention of the people (instructors, students, and others) who will engage with the courses.

**IMPLEMENTATION OF CHANGE: IT’S THE PEOPLE**

Curriculum design is only one component of educational reform. Once a curriculum is designed, it must be accepted, implemented, and sustained by individuals or groups within the organization. Depending on the scale of the curricular change, these phases may demand much more from those involved than a change in their individual activities or functions. Curricular change may also involve transformations in social structures and in social relationships and interactions—changes not merely within an organization but also of the organization [11-13]. As such, a rational solution to an identified need may not be sufficient to catalyze change within an organization. Large group adoption and implementation of curricular changes requires a consideration of context and sociocultural factors.

The curriculum design process is sometimes viewed by faculty as the first step in curriculum change, to be followed by the “hard work” of getting people to accept the change and adapt their behavior accordingly. This “product, then [local] politics” approach highlights the importance of human responses to the reform efforts. Implementation processes, once the “neglected member of the innovation family,” are now viewed as critical to the adoption of new approaches and the long-term success of change [14], and individual and group responses to proposed changes are described extensively in the organizational change and innovation literature. Successful implementation is known to require both a strong organizational climate for change, and a good fit between the organization’s values and the proposed innovation [15].

In 1971, Rogers and Shoemaker presented five critical, context-dependent dimensions that determine an innovation’s success or failure. These include (1) compatibility, (2) relative advantage, (3) complexity, (4) “triability”, and (5) observability of the change [16]. Faculty perceptions and presumptions are important, and individuals’ subjective (and often emotional) responses and orientations often determine the climate for educational change [14,17]. Successful implementation of curricular innovations has been shown to correlate positively with instructors’ perceptions of the relative advantage, compatibility, triability, and observability factors, and negatively to the instructors’ perceptions of the complexity of the change [14].

Many of Rogers and Shoemaker’s five critical dimensions are included in a discussion about the evolution of models for engineering curricular change in the...
Notably, Clark et al. note that approaches to curricular change were initially focused exclusively on developing the “best” curriculum. The steps in curricular change were seen as “develop the curriculum – pilot the curriculum – then a miracle happens and the curriculum is adopted.” As the work of the FC progressed, more insightful models of curricular change evolved, which included the need to “persuade others of the value of the new curriculum”, the need to “implement a curriculum that works for all students and faculty”, and the need to “create structures and mechanisms to sustain growth.” While curriculum design remained the nominal first step in the change process, these models increasingly recognized the role of people (particularly faculty and administration) in determining the success or failure of a curricular innovation. Notably, Clark et al. point out that these models are not sufficient, and that in particular they neglect to involve faculty members up-front[10,18].

Kolmos and de Graaf also address the question of how to achieve systemic change in engineering curricula. They observe that, in general, change in engineering education has been approached using an empirical-rational strategy – quite simply, if you prove that approach A is better than approach B, people will adopt approach A [19]. Although this strategy addresses the relative advantage and observability dimensions in a logical and direct manner, it fails to weigh the influence of its targeted users’ perceptions and preexisting values on their decision to embrace change. As Fullan notes, “The fallacy of rationalism is the assumption that the social world can be altered by logical argument. The problem, as George Bernard Shaw observed, is that “reformers have the idea that change can be achieved by brute sanity” [20]. Kolmos and de Graaf do recognize the limits of the rational approach to change. In their discussion, they acknowledge the importance of values in engineering educational reform, and they suggest that a normative-re-educational approach is most likely to lead to sustainable change, even if the outcomes are less definite than those provided by an empirical-rational strategy.

In the mid-1980s, Harvard Medical School (HMS) wrestled with many challenges during the implementation phases of the New Pathway curriculum, a reform effort featuring problem-based learning as its primary educational approach. The HMS faculty expressed a variety of practical and logistical concerns (e.g., faculty time and skills, finances), theoretical concerns (e.g., content coverage), methodologic concerns (e.g., balance of lectures and PBL), and “personal biases”[21]. Harvard’s solution was to create a separate, experimental track for the New Pathway program to “bypass the resistance of many members to significant change in the curriculum”[21]. Harvard implemented change by leveraging what Berg and Ostergren refer to as “cracks” in the system – venturesome individuals with system-divergent ideologies, interests, or goals who could be put into motion to drive the transformation[13,22]. To foster understanding and generate support among the entire faculty for the new curriculum, much effort was put into “mechanisms to inform the faculty and persuade them of the value of the problem-based approach.” [21] In the end, however, those committed to change were not forced to work with those opposed to it. HMS respected the differences in value and goal orientations among the faculty, and the new approaches were allowed to co-exist with more traditional teaching modes [22]. Harvard’s New Pathway curriculum successfully expanded to include additional faculty and most of the M.D. students. During expansion, HMS recognized the necessity of a transformation in faculty conceptions of learning and the nature of social relationships in the classroom. The school fostered individual transitions by providing an extensive faculty development program and a new rewards system and promotion criteria [23]. The New Pathway curriculum, while it did not spark systemic reform in graduate medical education, did attain enormous local success.

**INDIVIDUAL VALUES, EDUCATIONAL CHANGE, AND THE DESIGN PROCESS**

We propose that individual and group values are fundamental characteristics of the academic environment, and as such, they must be intimately linked to all stages of the curricular design, development, and implementation processes. Values are embedded in every reform attempt. Studies of social and organizational change demonstrate that an innovation-values fit can be critical to successful implementation or adoption of new approaches[15,24], yet an exploration of personal and group values is often overlooked in reform efforts.

Consideration and understanding of individual values are particularly important for educational systems, in which those responsible for change operate with strong personal beliefs and convictions. Paulston, in a critique of the deficiencies of the literature on educational change theories, notes that “people are attached to whatever they are doing because they believe in the value of it, not because they are resistant to change”[25]. Most faculty and administrators are committed individuals who are able to clearly express their personal values and describe how these values guide their work, their decisions, and their perceptions of an educational reform; they do not oppose change for the sake of opposition.

Coupled with a clear set of values is a high degree of autonomy and strong sense of curriculum ownership among faculty. This “extreme professional autonomy,” as van Vught describes it, has enormous impact on the success of educational changes [26]. Depending on the perceived congruence between the proposed change and individual values, a range of responses may result: opposition and resistance, disregard, indifference, relief, frustration and disappointment, or enthusiasm [15].

We posit that the best way to ensure a good fit between curricular change and the individual, group, and institutional values is through a mindful exploration of and reflection on these values throughout the design process. In the next section, we describe a user-oriented curriculum design...
process that we believe is sensitive to contextual factors and responsive to individual values considerations.

**User-Oriented Curriculum Design**

Above, we discussed models for curriculum design that, over four “generations,” increasingly involved the community, in order to facilitate adoption [10]. Here, we propose a “fifth-generation” user-oriented collaborative design model that might be summarized as “people-product-politics,” in which design and adoption are not discrete steps.

User-oriented Design Processes

As we argue above, common models for curriculum design tend to use a product orientation – they begin with requirements for the curriculum, such as learning objectives and they result in a specification for the curriculum.

An alternative approach would be to emphasize a user orientation and user participation in the design process. Rather than beginning the process with a set of requirements, one starts further “upstream,” with people. The design process initially focuses on understanding the potential users of the product and the context in which the product will be used. This people-oriented initial phase emphasizes empathy and values over product requirements. Only as the values, needs, and context of the users become defined does the process shift to be more product-oriented: requirements are defined and concepts for meeting these requirements are explored and selected, ultimately leading to a product specification. Despite this shift towards product orientation later in the process, user-oriented design explicitly maintains connection with users throughout the process, whether through formal collaborative mechanisms or through the empathetic designer-user relationship that is developed in the early phases.

Veryzer and de Mozota [27] argue that a user-oriented design approach improves both process and product. From a process perspective, user-oriented approaches often lead to more collaboration in the design process, rather than a division of labor. A deeper understanding of the users’ values, needs, and context can also improve the quality of idea generation. User-oriented approaches are thought to not only improve the final product quality, but also the level of product adoption by the users.

User-oriented Curriculum Design

Fundamentally, one designs curricula for people[28]. The product of a curricular design activity must not only meet constraints imposed by resource limitations, content requirements, and desired student outcomes, but also be responsive to the values, attitudes, and needs of the people who will interact with the curriculum. While educators are intuitively aware of this, in practice, we often only take such considerations into account implicitly. The application of user-oriented design processes to curriculum design would include explicit consideration of faculty, administrators, and students before the design of the curriculum begins.

A user-oriented curriculum design process begins by developing and articulating an understanding of the users, including their values and context. While it is common to talk about “institutional culture,” this culture reflects a communal set of values and beliefs. This is not the same as individual values (“I believe,” as opposed to “We believe” or “The institution believes”), and both should be considered in the design process. An important aspect of this process of understanding users is to make explicit what is often implicit; for example, the context of the curriculum is rarely explicitly described by curriculum designers, as an understanding of context is normally taken for granted. Formal tools, such as user personas, can be used to distinguish between the user and the designer, and to articulate the values and the context.

Once an understanding of the users of a curriculum has been developed, the process of identifying requirements can begin, and these requirements can incorporate the users’ values. The adoption of requirements that do not reflect the values of the users is problematic, as it will likely require a strategy to change user values, which should not be undertaken lightly. Having defined requirements, the process can transition into the more traditional mode of designing a curriculum to satisfy these outcomes, although with continued collaborative involvement of the users in the design process.

Merton et al. [29] and Clark et al. [10] reported on the successful adoption of the Sophomore Engineering Curriculum (SEC) at Rose-Hulman Institute of Technology. The development of the SEC was a highly participatory process that began with informal weekly meetings of faculty and continued with the development of a “skeleton” curriculum. This draft was presented to faculty in every department, and feedback was solicited and incorporated into the developing draft. This process led to significant support among the faculty, and approval and implementation of the SEC. Haglund et al. present another example of a user-oriented process in their description of curriculum reform at the University of Wisconsin-Madison [30]. They describe initiating a curriculum review and design process by focusing on the courses themselves. They quickly realized, however, that they needed to understand the values and ideologies of the faculty as a prerequisite to curricular evolution. Through interviews and an off-campus workshop, they fostered faculty participation in and understanding of the curriculum design process, and they developed and adopted a shared philosophy that was integrated into the design process.

The approaches to recognizing user values in the design process were markedly different at Wisconsin and Rose Hulman, as is appropriate, given the different institutional and individual values present at two very different institutions. The user-oriented curriculum design process, reflecting as it does the values and contexts of individuals, is highly local. While this is not at odds with leveraging work done at other schools, or the emergence of similar curricula,
it does preclude wholesale adoption of curricula created for different environments.

**CONCLUSIONS**

The widespread view that significant change is required in engineering education has led to broad efforts towards curricular reform. The expenditure of time and resources in these processes can be considerable, and the goals are worthwhile; we therefore have a strong interest in maximizing the likelihood of adoption of new curricula. Frequently, adoption is seen as a political problem that follows the design of the curriculum. We believe, though, that buy-in requires that the creation of a curriculum that is congruent with users' values. Furthermore, users must perceive the change as both meaningful and possible to implement. We suggest that a user-oriented curriculum design process is one method of formally incorporating the values and contexts of the users. A curricular reform process that reflects an understanding of the users will result in a better “product,” both in terms of content and in adoption.

**REFERENCES**


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