

AC 2008-85: THE BACHELOR OF ARTS IN ENGINEERING: A PARADIGM FOR BRIDGING THE LIBERAL ARTS AND ENGINEERING

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THE BACHELOR OF ARTS IN ENGINEERING: A PARADIGM FOR BRIDGING THE LIBERAL ARTS AND ENGINEERING

Abstract

The objective of this interactive panel session is to stimulate a discussion about a different approach to undergraduate engineering education: the Bachelor of Arts in Engineering degree. This degree exists at a handful of colleges/universities; many are very selective institutions. Some programs are fairly mature while several started within the last ten years. The flexibility of such a degree means that the programs are quite different in terms of curricula, students, and opportunities. Although the degree is far from mainstream, it is worthwhile to explore the question of whether this degree addresses some of the concerns about the need for a new approach to undergraduate engineering education, or if it is a specialty program only suited to certain contexts. In this session, several invitees discuss the Bachelor of Arts in Engineering Program at their colleges/universities. The discussion is organized around four main topics: 1) what is the objective of such a degree and how does it fit within engineering education, 2) what are the advantages of the degree for stakeholders (students, faculty, industry), 3) what are the disadvantages of the degree for those same stakeholders, and 4) what is the future for such a degree. Each panelist will briefly answer the topic while the overall panel fields questions from the audience. All discussions will be taped and transcribed and submitted for publication in a suitable venue. All session attendees will receive a copy of the written document.

Panelists

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The Issue

Technology encompasses what we do and what we dream of doing, but technology alone will not solve tomorrow's problems. Societal leaders must understand engineering's methods and values to successfully shape government and economic policies, design and interpret laws, teach future generations, produce creative work that reflects the modern world, and use technology themselves. Below are several selected quotes about this topic from national leaders and national reports.

“Undergraduate engineering should be reconfigured as an academic discipline, similar to other liberal arts disciplines in the sciences, arts, and humanities, thereby providing students with more flexibility to benefit from the broader educational opportunities offered by the comprehensive American university with the goal of preparing them for a lifetime of further learning rather than professional practice...The academic discipline of engineering (or, perhaps more broadly, technology) should be included in the liberal arts canon undergirding a 21st-century undergraduate education for all students.” (1)

“We aspire to an engineering profession that will rapidly embrace the potentialities offered by creativity, invention, and cross-disciplinary fertilization to create and accommodate new fields of endeavor, including those that require openness to interdisciplinary efforts with non engineering disciplines.” (2)

“Recognition of the importance of liberal studies in engineering education dates to the Morrill Act of 1862, which established the land-grant colleges. Since that time, there has been continuing concern that engineering education does not sufficiently incorporate liberal studies...As engineering and the technological revolution continue to transform our world, we must assure that those who steer these changes understand the totality of the human condition, and that brings us back to the liberal arts.” (3)

“Avoiding unintended consequences has never been more difficult or important than it is today ...In this evolving world, a new kind of engineer is needed, who can think broadly across disciplines and consider the human dimensions that are at the heart of every design challenge ...To better serve humanity, engineers must at least attempt to understand the human condition in all its complexity...The new breed of engineer will not only be a problem solver, but a problem definer ...” (4)

“... making sure that engineering at Harvard maintains a liberal arts focus means more than simply ensuring that engineering undergraduates have a background in the humanities and social sciences. Rather, it should work the other way as well, with students who do not specialize in engineering learning the skills necessary to work with emerging technologies...the liberal arts concept has to change with the times. Technology is everywhere. So the liberal arts education of the 21st century has to be different. You will not be a broadly educated person if you're not comfortable with the world of technology, and that's the message...” (5)

“I'm not saying that every politician needs to be an engineer, but it would be helpful if they had a basic understanding of the forces that are flattening the world.” (6)

These speeches and the many reports on the subject call for a different approach to undergraduate engineering education. Such statements emphasize the need for engineers who can define problems as well as solve them as they deal with economic, environmental, political, and social considerations. In particular, the current sustainability and service-learning themes capture many of these contextual considerations for engineering education. These national policy discussions also suggest that such an approach to undergraduate engineering education may lead to more women and minorities entering the profession, provide US engineers with a competitive advantage in the global engineering workforce, and help to develop leaders throughout society who are equipped with a technological foundation. In other words, as shown in Figure 1, the majority of recent reports suggest that we need more undergraduate curricular opportunities that bridge engineering and the liberal arts so that more graduates are prepared to be leaders in this complex, technological age. Engineering students need access to the benefits of a liberal arts education, and at the same, time non engineering majors need to improve their understanding of engineering.

The Alternatives

As shown in Figure 2, current efforts to reform undergraduate engineering education to prepare graduates to take leadership roles throughout our economy (as opposed to only traditional engineering sectors) fall into three categories: (a) incorporate more liberal arts into engineering education, (b) educate non-engineers about engineering, and (c) integrate many disciplines into a coherent educational experience. Each category is briefly described below with some examples.

Liberal Arts for Engineers:

- 3-2 program with B.A./B.S. (ABET-accredited) from 2 different collegesⁱ
 - E.g. Williams College (B.A.) and Columbia University (B.S.)
 - Provides an alternate 5-year pathway to an undergraduate disciplinary specific B.S. engineering degree. The student does not have to commit in the 1st year and can pursue a liberal arts core and a liberal arts concentration.
- ABET-accredited B.S. Engineering (general) degree programs at liberal arts colleges
 - E.g. Swarthmore College, Smith College, Harvey Mudd College
 - Provides a general B.S. engineering degree (without a specialty) that is ABET-accredited. The degree emphasizes engineering science over engineering design, and includes more flexibility for liberal arts courses than a disciplinary-specific B.S. engineering degree.
- Integrated 5-year B.A./B.S. engineering degree programs
 - E.g. Dartmouth College, University of San Diego
 - Provides a 5-year undergraduate education at the same institution so that engineering students can get both the liberal arts preparation via the B.A. degree, and the technical preparation via an ABET-accredited B.S. degree.
- Honors Programs for Engineers that emphasize liberal arts – different models
 - E.g. University of Wisconsin-Madison’s Engineering Honors in Liberal Arts, Colorado School of Mines’ McBride Honors Program, Georgia Institute of Technology’s McEver Program for Engineering and the Liberal Arts

ⁱ This is a historical solution, however there are also some new 4+2 programs leading to ABET-accredited M.S. or B.S. engineering after 4-year liberal arts degree e.g. Northeastern University.

- Provides the highest academically ranked engineering students with an enrichment curriculum that is focused on the liberal arts and leadership skills.

Engineering for Liberal Arts:

- Stand-alone B.A. Engineering degree programs
 - Existing programs e.g. Lafayette College, University of Arizona, Harvard University, John Hopkins University, (and Dartmouth College if students do not opt for the B.S. degree)
 - New B.A. Engineering programs e.g. Worcester Polytechnic Institute, California Polytechnic University (proposed)
 - B.A. Engineering programs embedded in traditional departments e.g. Yale University, Johns Hopkins University
 - Princeton University's tracks for Liberal Arts and Engineering within some of the ABET-accredited B.S. Engineering degree programs
 - Lehigh University's IDEAS B.S. program that integrates the arts, engineering, and sciences into one non-ABET accredited degree [Students have the option to structure their curriculum so they can also get a traditional B.S. degree.]
 - Provides a technical liberal arts preparation for non-engineering design careers. These programs retain students who become disillusioned with design in engineering departments and engineering colleges.
- Engineering courses for non engineers included in the general education requirements
 - E.g. Princeton University's *Center for Innovation in Engineering Education* with multiple courses, Harvard University's freshman course(s) titled *Introduction to the World of Technology*, Union College's *Converging Technologies Program*
 - Provides engineering courses for non-engineers in an effort to improve technological literacy.

Multidisciplinary Engineering and Liberal Arts:

- Project, research, and seminar courses that enroll multiple majors
 - E.g. Purdue University's EPICS Program (project-based service-learning course with students of different majors), University of Maryland's Gemstone Program (multidisciplinary four-year program for selected undergraduate honors students of all majors who design, direct and conduct research exploring the interdependence of science and technology with society as part of a living-learning community), Union College's *Converging Technologies Program*
 - Provides multidisciplinary curricular opportunities for students who value the contributions of different disciplines to solve complex problems.

Considering B.A. Engineering Programs in More Depth

In this panel session, we consider the advantages and disadvantages of offering the Bachelor of Arts in Engineering degree, a liberal arts degree with an engineering emphasis. Given that the degree is intended for liberal arts majors, we include a breakdown of liberal arts colleges that offer this degree. Table 1 shows the top 40 liberal arts colleges for 2008 as ranked by US News and World Report. At these colleges only eight offer engineering degree programs, though several have 3-2 articulations with engineering colleges at other universities. Of those eight, five

offer degrees within specific engineering disciplines, and only one, Lafayette College, offers a B.A. Engineering degree. However, the degree is offered at a wide variety of institutions besides liberal arts colleges. Based on recent review (may not be inclusive), a B.A. Engineering degree (or very similar) is offered by Harvard University, Yale University, Dartmouth University, Princeton University, John Hopkins University, University of San Diego, Worcester Polytechnic Institute, George Washington University, and University of Arizona. Lehigh University recently (with the Class of 2011) added a 4-year degree known as the Integrated Degree in Engineering, Arts, and Sciences (IDEAS) that integrates liberal arts and engineering. And, California Polytechnic University is in the process of implementing such a degree. There may be other colleges offering similar degrees that we are not aware of.

It is worthwhile to discuss the merits of a B.A. Engineering degree because it is an established curriculum that has the potential to address many of the problems discussed in the slew of national reports. The degree already provides liberal arts majors with a comprehensive understanding of the engineering field. And, the degree is well suited as a pre-engineering degree for an educational model that favors graduate education similar to the health and law professions. There also appears to be a renewed interest in the degree as demonstrated by several new programs within the last five years. In other words, the B.A. Engineering degree offers the possibility of an undergraduate liberal arts major that both prepares those majors to address the technical challenges of other professions, and prepares a subset for graduate level education in specific engineering disciplines. As such, the objectives of the panel discussion are a) to compare experiences among the few institutions that offer such a degree, b) to inform a larger set of institutions about such a possibility, and c) to further the discussion of such a degree as an alternative for expected changes to engineering education at the undergraduate level.

The panel includes representatives from several of the institutions mentioned above that offer the B.A. Engineering degree. The session begins with an overview of the panel objectives. Each of the panelists then presents a brief overview of his/her institution's B.A. Engineering degree program. The panelists are asked to specifically address the following: what is the objective of such a degree and how does it fit within engineering education, what are the advantages of the degree for stakeholders (students, faculty, and industry), what are the disadvantages of the degree for those stakeholders, and what is the future for such a degree. The panel then receives questions from each other and the audience facilitated by the session chair. The complete discussion is taped and transcribed with the results included in a subsequent publication after review by the panelists. This publication will be sent to all attendees and will be presented at a relevant venue in the near future.

References

1. Duderstadt, J. Engineering for a Changing World: A Roadmap to the Future of Engineering Practice, Research, and Education, The Millennium Project, The University of Michigan (©2008)
2. National Academy of Engineering, The Engineer of 2020: Visions of Engineering in the New Century, National Academies Press, D.C. (2004)

3. Jackson, S., Engineering and the Liberal Arts, Designing the Future: A Summit on Engineering Education, Smith College, Northampton, Massachusetts, March 31 (2001) (speech)
4. Grasso, D. & Martinelli, D., Holistic Engineering, The Chronicle Review, March 16 (2007)
5. Kaletzky, M. Harvard Institute of Technology? FAS-ordained Engineering School Seeks to Define a Place for Engineering in a Liberal Arts Education, The Harvard Crimson, June 6 (2007) [quotes of Venkatesh “Venky” Narayanamurti, Dean, School of Engineering and Applied Science, Harvard University]
6. Friedman, T., The World is Flat: A Brief History of the Twenty-first Century, Farrar, Straus and Giroux Press (2005, 2006, 2007)

Figure 1. The Role of Engineering and the Liberal Arts for the 21st Century

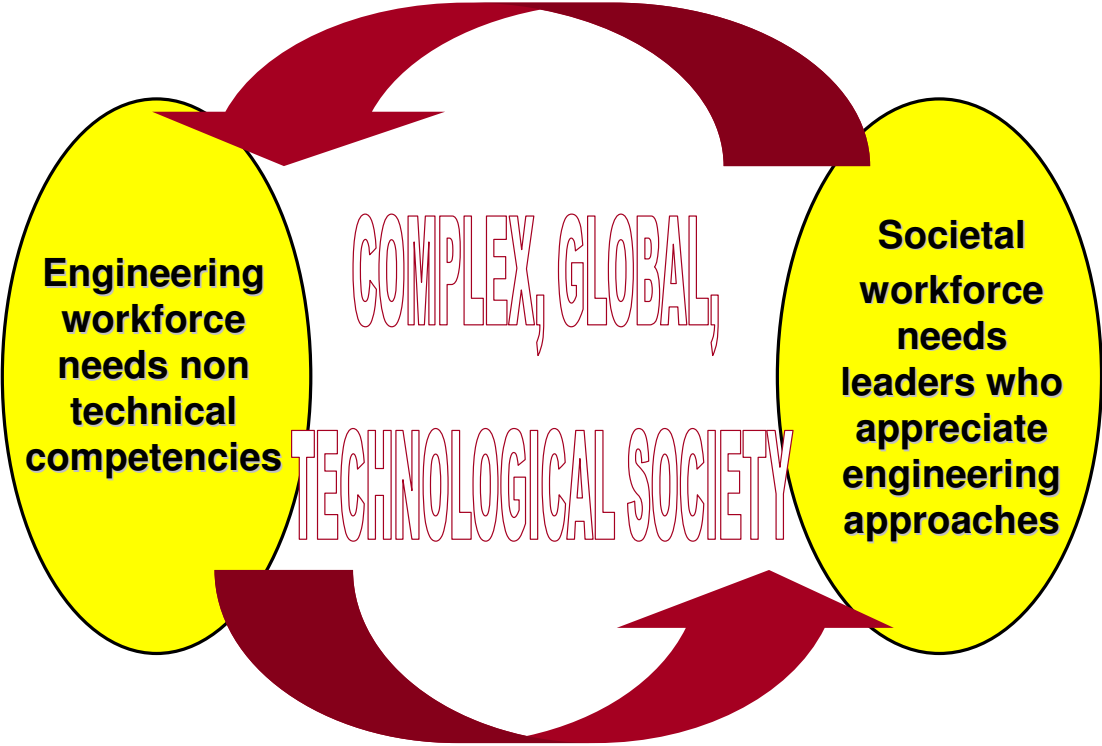


Figure 2. Current Alternative Approaches to Prepare Technological Leaders

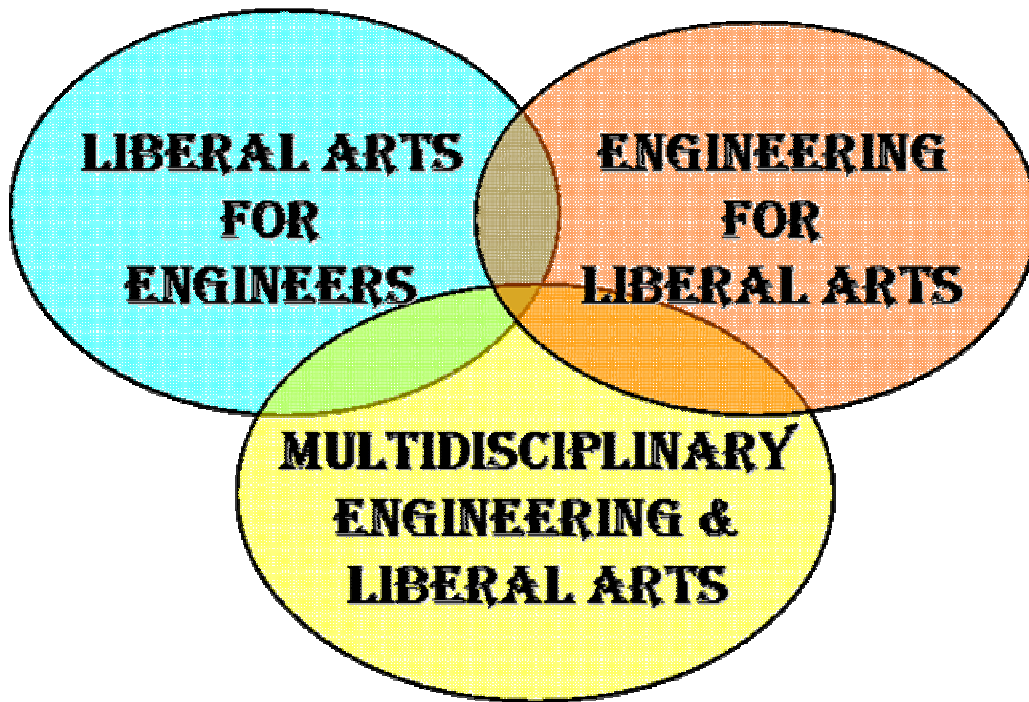


Table 1. Engineering Programs at Liberal Arts Colleges

Liberal Arts College	Undergraduate Engineering Degree	Multiple Engineering Disciplines	B.A. Engineering Degree
Williams College			
Amherst College			
Swarthmore College			
Wellesley College			
Carleton College			
Middlebury College			
Pomona College			
Bowdoin College <input type="checkbox"/>			
Davidson College			
Haverford College <input type="checkbox"/>			
Claremont McKenna College			
Wesleyan University			
Grinnell College			
Vassar College			
Harvey Mudd College	Yes		
Washington and Lee University			
Smith College	Yes		
Hamilton College			
Colgate University			
United States Naval Academy	Yes	Yes	
Oberlin College			
Colby College			
United States Military Academy	Yes	Yes	
Bates College			
Bryn Mawr College			
Colorado College			
Macalester College			
Scripps College			
Mount Holyoke College			
Barnard College			
Bucknell University	Yes	Yes	
Kenyon College			
College of the Holy Cross			
Trinity College	Yes		
Lafayette College	Yes	Yes	Yes
Occidental College			
Bard College			
Furman University			
Whitman College			
Union College	Yes	Yes	