Engineering and Engaged Scholarship at Penn State

Part I: The Rationale

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Abstract – The objective of engineering education is to educate students who are ‘ready to engineer’. This implies that students should be broadly prepared with not only deep knowledge and understanding of the technical fundamentals, but also the pre-professional skills required to be successful in the engineering workplace of today and tomorrow¹. Part I of this paper includes a brief rationale and need for ‘engaged scholarship’ to help accomplish these goals, and the inherent need for a robust ecosystem to support it. A summary is provided of the outcome-based objectives for the training of engineers as well as the industry-identified personal competencies required. The role of the university in engaged scholarship is examined along with the benefits and impediments to its implementation. A definition of educational ecosystem is provided. Part II details the existing engaged scholarship ecosystem in the College of Engineering at the Pennsylvania State University, while Part III provides an overview of how this assortment of minors, certificates, programs, courses, and student organizations is being integrated and institutionalized into a strategic mission for the University.

Index: engaged scholarship, service learning, educational ecosystem

INTRODUCTION

There have been a number of national surveys of corporate recruiters and employers to seek input on what employers look for in undergraduates. The National Association of Colleges Employers Job Outlook Survey² (2014) identified the five top personal qualities or skills that employers seek:

- Ability to make decisions and solve problems
- Ability to verbally communicate with persons inside and outside the organization
- Ability to obtain and process information
- Ability to plan, organize, and prioritize work
- Ability to analyze quantitative data

In an April 2013 report³, the Association of American Colleges & Universities (AAC&U) surveyed employers on their priorities for college learning and student success. In this report, employers identified cross-disciplinary skills and knowledge as critical to a student’s potential for career success, and “they view these skills as more important than a student’s choice of undergraduate major”. In addition:

- Nearly all those surveyed (93%) agreed, “a candidate’s demonstrated capacity to think critically, communicate clearly, and solve complex problems is more important than their undergraduate major.”
- More than nine in ten of those surveyed said it is important that those they hire demonstrate ethical judgment and integrity; intercultural skills; and the capacity for continued new learning.
- More than three in four employers say they want colleges to place more emphasis on helping students develop five key learning outcomes, including: critical thinking, complex problem-solving, written and oral communication, and applied knowledge in real-world settings.

Although the surveys listed above are not discipline specific, they are no doubt indicative of attributes sought by employers across all disciplines. More mundane to engineering, reports on engineering education make clear that additional enhancements are needed to prepare engineering graduates to meet the challenges of the twenty-first century^{4,5a}. One of the keys to preparing students to meet these challenges is to help them build knowledge and skills that they can readily adapt to address the novel, complex problems that they will encounter.

Engineering education and the success of its outcome-based methodology has been under review^{5b,6a}. The Accreditation Board for Engineering and Technology (ABET) guides engineering educators in formulating both curricula and associated coursework. The student outcomes are listed in Criterion 3 (a-k). These outcomes describe what students are expected to know and be able to do by the time of graduation. The outcomes criterion 3(a-k) are listed below in Table 1.

TABLE 1
ABET CRITERION 3A-K

- a. an ability to apply knowledge of mathematics, science and engineering
- b. an ability to design and conduct experiments, as well as to analyze and interpret data
- c. an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- d. an ability to function on multidisciplinary teams
- e. an ability to identify, formulate, and solve engineering problems
- f. an understanding of professional and ethical responsibility
- g. an ability to communicate effectively
- h. the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
- i. a recognition of the need for, and an ability to engage in life-long learning
- j. a knowledge of contemporary issues
- k. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

A number of authors have questioned this outcomes-based engineering education and suggest that it falls short of the goal of adequately preparing students for professional practice^{6b-9}. Others indicate that “many of the students who make it to graduation enter the workforce ill-equipped for the complex interactions [...] of real world engineering systems”¹⁰. Such concerns

imply that industry requires more adequate preparation of students for the complex and socially situated job aspects of real-world engineering¹¹. Conversely, “much of the energy in teaching and learning in universities is still focused on developing the observable skills and knowledge dimension”¹¹, rather than the less easily observable attributes required by industry.

This disconnectedness suggests that the educational ‘outcomes’ in engineering education may not be adequate in preparing students to be part of a profession that is grappling to “fully assume its expanding responsibility”^{12,13}. It also suggests that engineering students’ overall learning experience should incorporate broader, attitudinal aspects of competence which is not sufficiently inherent in current curricula. There are difficulties in incorporating such an approach in the context of engineering learning¹⁴. Time constraints, requirements for pre-requisite coverage of material, and instructor training are but a few of the factors which may limit development of the competencies identified by industry as needing improvement.

The notion that the concept of outcomes-based education might be limited in its capacity to capture all aspects of engineering learning is supported by growing evidence. A wide range of educational factors interact in a complex fashion to impact students’ professional formation on the level of both specific learning outcomes and intangible, attitudinal aspects¹⁵⁻²³. Competency requirements of design engineers include those underlying motives, traits, values, knowledge, and skills that are causally linked to effective job performance²⁴. An abbreviated future competency profile for design engineers is shown in Table 2. Competency expectations from employers are grouped into six competency groups: personal attributes, project management, cognitive strategies, cognitive abilities, technical ability, and communication²⁵. The Competencies in each Competency Group are in order of importance for the design engineer.

TABLE 2
DESIGN ENGINEER COMPETENCY PROFILE²⁵

Competency Group	Competencies	
Personal attributes	Is motivated Works hard Enjoys challenges Is assertive Is open minded	Has good interpersonal skills Is self-confident Proactively seeks training Copes with ambiguity
Project management	Plans work Monitors progress Seeks support from others Manages problems	Manages time Understands the task Conducts risk assessments
Cognitive strategies	Judges importance Analyses tasks	Identifies factors Learns from mistakes
Cognitive abilities	Makes effective decisions Thinks intuitively	Thinks ‘outside the box’ Is able to learn
Technical ability	Uses effective learning methods Is knowledgeable about engineering Applies engineering knowledge	Is technically versatile Has IT skills Visualizes geometry in 3D
Communication	Uses appropriate communication formats	Summarizes information

This is of particular note given that industry surveys detail what engineers should possess in terms of core competencies. It is interesting to note that only 47% of design engineer's time was spent engaged in such design process steps²⁶. The remaining 53% was spent planning work, reviewing/reporting, estimating cost, retrieving information, interacting socially, and helping others.

The Role of the University

According to a report in the Chronicle of Higher Education²⁷, a survey of employer perceptions noted that “when it comes to the skills most needed by employers, job candidates are lacking most in written and oral communication skills, adaptability and managing multiple priorities, and making decisions and problem solving”. In addition, employers place the responsibility on colleges and universities to prepare graduates in written and oral communications and decision-making skills. The survey results suggest that employers believe that colleges need to “work harder to produce these traits in their graduates”.

More specific to engineering, the National Science Foundation (NSF) and American Society for Engineering Education (ASEE) report entitled ‘Transforming Undergraduate Education in Engineering: Synthesizing and Integrating Industry Perspectives’²⁸ sought to produce a clear understanding of the qualities engineering graduates should possess in order to encourage changes in curricular, pedagogy and academic culture. Participants from companies across the United States included representatives from: global and domestic companies, defense contractors, those that hire multiple engineering disciplines, wide age ranges, administrative and design engineers, government, and university relations. Academics were invited as well to offer ideas on how the curricula could be adjusted to meet employer needs. These participants were asked to identify the knowledge, skills and abilities (KSAs) they felt would be demanded of engineers in the coming years and who is responsible for the attainment of the KSAs.

First, they identified the stakeholders who might be primarily tasked with having students attain each of the KSAs (Table 3).

TABLE 3
 STAKEHOLDERS IN KNOWLEDGE, SKILLS, AND ABILITIES ACQUISITION

Students	Students and Parents
Parents	Students and Academia
Academia	Students and Industry
Industry	Parents and Academia
Other	Academia and Industry
	Students and Academia and Industry
	Parents and Academia and Industry

Participants then generated a list of knowledge, skills and abilities crucial for the engineering profession (Table 4) and assessed responsibility for student achievement of the various KSAs goals. As is evidenced in the table, academia is looked upon as the stakeholder responsible for many of the KSA's that are to be attained by students. Note: the numerical values shown in Table 4 indicate the percentages of participants who felt that academia was the primary stakeholder responsible for that KSA, or else shared responsibility with one or more of

the other stakeholders (thus not summing to 100% as combinations of ‘others’ may constitute the differences).

TABLE 4
RESPONSIBILITIES ACROSS STAKEHOLDERS FOR KNOWLEDGE, SKILLS AND ABILITY EDUCATION

Responsibility of:	Students	Parents	Academia	Industry	Shared Responsibility w/ Academia
Good communication skills			23%		57%
Physical science and engineering science fundamentals			96%		4%
Ability to identify, formulate and solve engineering problems	4%		40%	4%	51%
Systems integration			13%	13%	70%
Curiosity and persistence	28%	8%	8%	4%	48%
Motivation	28%	20%	4%		44%
Cultural awareness		16%	12%	4%	18%
Economics and business acumen			20%	20%	60%
Ethical standards and responsibility	4%	12%	12%		80%
Critical thinking	4%	4%	71%		19%
Prioritize efficiently	8%	17%	17%	8%	50%
Project Management	4%		21%	29%	46%
Teamwork	13%		33%	4%	38%
Entrepreneurship	17%		17%	4%	40%
Use new technology and engineering tools			18%	35%	47%
Public Safety			12%	24%	41%
Information Technology	6%		39%	28%	17%
Applied knowledge of engineering core sciences	5%		42%	26%	27%
Data interpretation and visualization			72%		22%
Leadership	5%	10%	10%	24%	52%
Creativity	6%		33%		60%
Emotional intelligence	11%	32%		16%	27%
Application based research and evaluation skills			56%	25%	
Ability to create a vision	6%	13%	13%	25%	25%
Professional judgment	6%	18%		18%	26%
Ability to adapt to rapid change	18%	18%	6%	24%	20%
Ability to deal with ambiguity and complexity	6%		53%	18%	18%
Innovation	13%		25%	13%	25%
Metacognition/technical intuition	24%	6%	24%		30%
Understanding of design	6%		56%	13%	25%
Conflict resolution		18%	12%	18%	41%

- Red indicates University role is critical
- Yellow indicates the University has a significant role and/or one shared with other entities

BENEFITS OF ENGAGED SCHOLARSHIP IN ENGINEERING

The Pennsylvania State University defines engaged scholarship as “any scholarly activity that integrates elements of teaching and learning, research and creative accomplishments, and service

in a synergistic manner between the classroom and experiences outside of the classroom in a broader community.” The University has recently revised this definition as follows: “engaged scholarship activities are out-of-the-classroom academic experiences that complement and support learning that takes place in the classroom”. There is a substantial and yet rapidly expanding body of literature showing that one form of engaged scholarship, service learning, has been positive for students, faculty, educational institutions, and community partners²⁹⁻³⁷. Such methods have proved so overwhelmingly successful that the Kellogg Commission concluded that this form of engaged scholarship “should be viewed as among the most powerful of teaching procedures, if the teaching goal is lasting learning that can be used to shape student’s lives around the world.”³⁸. Research in this area has been maturing quickly. It is now well established that service learning as engaged scholarship has a positive impact on students’ academic learning, moral development, improves students’ ability to apply what they have learned in the “real world”, and improves academic outcomes as demonstrated complexity of understanding, problem analysis, critical thinking, and cognitive development³⁹⁻⁴³.

The largest benefactors of an experiential education approach are students, who are more motivated, work harder (and longer), learn more, and experience lasting benefits from their experience⁴⁴⁻⁴⁹. Bielefeldt et al.⁵⁰ summarized a wide range of outcomes that have been achieved in engineering using Learning Through Service methods. This included all of the ABET a-k outcomes⁵¹ and many of the additional ASCE Body of Knowledge 2nd edition outcomes⁵². Jaeger and LaRochelle mapped EWB activities with all of the ABET a-k outcomes⁵³. Faculty who have incorporated engaged scholarship into courses have direct evidence of student learning via students’ performance on traditional graded assessments, such as homework, lab reports, and exams. There also is interest in evaluating whether engaged scholarship provides additional learning benefits over other teaching methods. This information is less widely available because it would require a controlled study where some students do not participate in engaged activities. The data on the benefits of Learning Through Service toward student learning includes primarily indirect evidence that is self-reported by students. There are also anecdotal reports from many engineering professors⁵⁴.

Leadership⁵⁵, teamwork, multidisciplinary teams, self-efficacy, ethical awareness, and project management are all positively impacted using this pedagogy⁵⁶, as are the student’s awareness of the impacts of engineering on society, contemporary issues, modern engineering tools, communication, and teamwork skills. Beyond these skills, the service learning experience impacts students’ attitudes about community service, the professional responsibilities of engineers, and their motivation to remain in engineering. Diversity is enhanced as indicated in studies that show that women are drawn to programs such as EPICS and EWB⁵⁷⁻⁵⁹. Finally, engaged scholarship courses have been shown to make a positive material difference in the real world.

The true power of engaged scholarship may be its ability to achieve a wide array of learning outcomes, many of which being more difficult to achieve with traditional methods, in an efficient manner⁵⁴.

ENGINEERING AND ENGAGED SCHOLARSHIP AT PENN STATE UNIVERSITY

The engineering curriculum is a challenging undertaking. The credit load and rigorous coursework provides the student with the prescribed basics in: general education, sciences, engineering sciences, and engineering design, culminating in a capstone design experience.

Little room is left for specific focus, integration, practice and assessment of all of the KSAs listed above in Table 2. Taking note of the KSAs listed above, as well as the benefits associated with engaged scholarship in meeting many of those objectives, Penn State's College of Engineering and faculty have developed an array of minors, certificates, programs, courses, partnerships, and student organizations which embrace the pedagogy of engaged scholarship and address many of these goals. These efforts are summarized in Table 5.

TABLE 5
CURRICULAR, CO-CURRICULAR AND EXTRA-CURRICULAR EFFORTS AT PENN STATE

Efforts	Current Faculty	Years
Curricular		
Engineering Leadership Development Minor (ELDM)	Andrew (Mike) Erdman	1994-2014
Intercollege Minor in Entrepreneurship and Innovation Minor (ENTI)	Elizabeth Kisenwether	2000-2014
Sustainability Leadership Minor	Dr. Susannah Barsom	2012-2014
Humanitarian Engineering Development	Dr. Thomas Colledge, PE	1998-2011
Engineering and Community Partnerships		2011-2014
Engineering and Community Engagement Certificate (ECE)		2008-2014
International Journal for Service Learning in Engineering, Humanitarian Engineering and Social Entrepreneurship (IJSLE)		2005-2014
Humanitarian Engineering and Social Entrepreneurship (HESE)	Khanjan Mehta	2011-2014
Learning Factory Capstone Design	Dr. Mary Frecker	1994-2014
Co-Curricular		
Engineering Internships and Coops	Rick McClintic	-
American Indian Housing Initiative (AIHI)	Dr. David Riley	2001-2014
National Energy Leadership Corps (NELC)		2012-2014
Engineering Ambassadors	Dr. Karen Thole	2009-2014
Engineers Projects in Community Service (EPICS)	Timothy Wheeler	2001-2114
Extra-Curricular		
Engineers Without Borders	Dr. Rachel Brennan, PE	2010-2014
Engineers for a Sustainable World	Andrew Lau	2002-2014
Global Water Brigades	Dr. Michael Saunders	2011-2014
Bridges for Prosperity	Thomas Skibinski, PE	2013-2014

'Ecosystem' Defined

Historically, the educational paradigms at universities have been fragmented by discipline, faculty roles, and responsibilities. Often, the joint missions of the university – research, teaching, and outreach – have been seen as disparate and competing requirements by faculty⁶⁰. The Penn State programs listed above seek to break out of such silos. University faculty have employed pedagogies which establish synergies between extra-university opportunities and education through the programs listed. Figure 1 provides a map of these synergies across the joint university missions. The goal is to couple the teaching, research and outreach efforts of

faculty and the institution to enhance the learning, discovery and engagement on the part of students, projects and communities.

FIGURE 1
 COMBINATIONS AND SYNERGIES BETWEEN UNIVERSITY MISSIONS⁶⁰

As successful as these Penn State minors, certificates, programs, courses, partnerships, and student organizations have been, however, there is no generic framework available to describe how all of these activities combine in a self-sustaining, optimal fashion. A successful framework would allow all parties to achieve independent goals in a complementary community context, providing resources and opportunities to all parties resulting in net benefits⁶⁰.

Pearce and McCoy (2007) suggest that the metaphor of the ecosystem is one possible structure that could provide a basis for this type of generalizable, repeatable system. At its most basic, an ecosystem consists of a set of organisms that interact with one another, along with the environmental context in which they exist⁶¹⁻⁶³. Ecosystems have multiple attributes that provide a useful metaphor for the type of system being modeled:

1. Scalability – the ecosystem concept can be applied at a scale as broad as the whole biosphere, or as small as a puddle⁶².
2. Variable system boundaries – based on the phenomenon being studied or the question being asked, what is considered inside vs. outside the system varies, in contrast with an individual organism that is typically defined with fixed boundaries (ibid.).
3. Characteristic diversity of major functional groups – multiple organisms with complementary needs and abilities coexist together⁶³.
4. Productivity and biogeochemical resource cycling – as part of their existence, ecosystems absorb matter and energy from their context and change its state to meet the needs of ecosystem function, generally resulting in localized reduction of entropy into useful products (ibid.).
5. Dynamic responses to contextual perturbations – ecosystems are not static over time, but can still remain stable and sustainable as they adapt to changing contexts and stochastic events (ibid.).
6. Coupled relationships between system and context – ecosystems are affected by, and likewise have the ability to affect, their contexts (ibid.).

These attributes of ecosystems establish a metaphor that can be applied to teaching, research, and engagement. They help describe the type of sustainable synergies that are currently unrealized⁶¹. Key considerations of the notion of ecosystem applied to education include: the stakeholders in the ecosystem; their interests, resources, and roles in the system; and transactions and relationships connecting the parties. In terms of systems theory, each entity is simultaneously a whole unto itself while being a part of a larger system⁶⁴. In this paper, the educational ecosystem is comprised of five subsystems (students, faculty, programs, administration/support, communities) which may exist and function independently in the status quo, but are drawn together to create synergy and provide products, services, and information to one another as they interact together.

BARRIERS TO CREATING AN ENGAGED SCHOLARSHIP ECOSYSTEM

In seeking to develop, or enhance, a more ‘engaged scholarship ecosystem’ at Penn State, it is useful to identify some of the existing barriers within the current university framework.

Logistical Support

Projects are most often identified and championed by faculty members. With the project comes a long list of issues which historically has been the responsibility of the faculty member to shoulder. To a large extent, these issues are often the reasons faculty consider community engagement to be so cumbersome. Some of these issues include: communication with the community partner, funding acquisition, familiarization and comfort with the pedagogy, preliminary site visits, as well as actual implementation and project construction visits. The list goes on: student funding support, ticketing and travel, materials and supplies, passports/visas, transportation arrangements, scheduling issues, and marketing/promotion, satisfying department and college requirements for receiving credit for projects, time in students schedules for multidisciplinary teams, funding for conferences and workshops. Jeff Brown (Embry Riddle University) sums this up as ‘heroic management of ad-hoc, chaotic processes’.

Promotion and Tenure Support

Feedback from students relative to their experiences with engaged scholarship is typically very positive. They express that for the first time they felt as if they were making a difference, applying their academic skills, and impacting a real client. From a teaching perspective, the pedagogy serves to bolster the teaching component of a faculty member’s dossier. What may have been lacking from a P&T perspective are the research and scholarship components. Overall, engineering education research and practice have assumed a higher degree of scholarly attention over the past decade. Such research efforts on the efficacy of service learning in engineering, humanitarian engineering and technically-based social entrepreneurship, and their impact on pre-defined learning outcomes, are part of a growing cross- and inter-disciplinary field of scientific inquiry. The need for increasing the level of scholarship in these areas is driven by the current reward system – the promotion and tenure (P&T) review process. In a national survey of 109 college administrators, including chairs, department heads, and college deans⁶⁵ found considerable uniformity across institutions concerning what these gatekeepers regarded as criteria of merit. See Table 6.

These performance criteria indicate that service is limited in value in the P&T process, while publications are weighted heavily – particularly publications in print media.*

TABLE 6
P&T CRITERIA OF MERIT

100	Book that advances knowledge in candidate's field
97	Published refereed articles or reports in print media
83	Extramural grants or contracts
76	Teaching awards or nominations
63	Favorable written student teaching evaluations
47	Presented papers at conventions
46	Published refereed articles or reports in online media
21	Favorable evaluations of student advising
14	Developed and managed an online course
10	Member has participated in major committees
0	Recognition for significant service to community

The work undertaken by practitioners of engaged scholarship over the years has clearly been conducted in a scholarly manner. But relative to the level of scholarship being undertaken, several issues have surfaced which need to be addressed:

First, faculty must examine the level of rigor of their work. The efforts undertaken by faculty in the area of engaged scholarship are often of high value to the collaborating communities, but may not contain a high degree of engineering expertise as deemed appropriate by the more traditional engineering disciplines. However, given the highly interdisciplinary nature of our work, it is important to note that there is plenty of highly interdisciplinary research that is very rigorous.

Second, relative to ‘breaking new ground’ or being ‘innovative’, many projects have a technical component, and maneuver through complex social and economic constraints to achieve success. Unfortunately, an examination of what is technically ‘innovative’ or ‘breaking new ground’ often leaves one searching. Perhaps the innovations sought should be in the form of engineers engaging communities (e.g., moving away from paternalistic approaches towards true partnerships) and in the way the teaching of engineering students is undertaken (e.g., pedagogies of engagement). Care should be taken not to have a narrow conception of innovation (e.g., groundbreaking technologies like the iPhone) relative to a focus on processes (e.g., the ways we engage students and communities).

Thirdly, based on the characteristics of scholarship listed above, many of the manuscripts do not offer solutions or methodology which can be replicated as they are very much case-based; that is, specific to a certain location or setting.

* The authors used an average z-score for each criterion, and using a simple transformation, assigned the lowest in the array a zero and the highest a score of 100. The result is a set of weights that correspond to each of the criteria. This method provided a numerical continuum along which the common criteria for assessing the academic performance of faculty could be assessed.

As suggested by Juan Lucena (Colorado School of Mines), it should be remembered that such efforts are ‘interdisciplinary-focused rather than strictly discipline-focused. As such, care should be taken to avoid falling into the entrapments of disciplines. Disciplines become silos, ivory towers, with specialized jargon that often makes them irrelevant and disconnected to the real problems of the world’. Instead of being discipline-driven, efforts are problem-driven where the core problem being addressed is “How can engineering serve the problems of demographic groups (e.g., poor, disabled, ill, disaster stricken, etc) that have been ignored for so long”?

It would seem an effort is being made to enhance scholarship in a somewhat new field – sharing some goals with traditional engineering disciplines but diverging from those traditional disciplines in others – all the while being evaluated based on criteria of the traditional disciplines. Review committees still have as their primary criteria that of recognizing scholarship which is driven by recognition of quality research and its dissemination through respected scholarly publications. Toward that end, a thrust in engaged scholarship seeks to provide a framework for high quality, rigorous, scholarly research undertaken in an interdisciplinary fashion (with interdisciplinary going beyond integrating different disciplines of engineering).

Teaching Loads, Team Teaching, and Time Commitments

Preparing a course in which students are engaged with a community-based project requires a significant amount of time to prepare. The issues identified in the earlier section on Logistical Support document many of the reasons why. But beyond this, just as with projects on the job, the dynamic and realistic aspects of the projects require time on the part of the faculty member. And given the multi-disciplinary nature of the projects and their solution, it is often necessary for faculty to engage in some form of team teaching. This often portends its own difficulties – coordinating multiple faculty members on a specific project. To assist with guidance and scaffolding of instruction required on projects, teaching assistants are often of great value. Issues related to funding for the TAs as well as their training become issues to be addressed.

Lack of Collegiality and Support Structure for Faculty

A very often cited complaint among those that engage in engaged scholarship is the lack of a community of practice to interact with. The desire and need for communication, support, and sharing would assist in nurturing the efforts and motivation the practitioners. Such support groups also serve a valuable role in the dissemination of information regarding best practices and methods, and also in building a spirit of the community of practitioners. These groups can also facilitate coordination and leveraging of resources and information between various programs.

Silos and Limited Interdisciplinary Engagement

The problem of educational silos overlaps with the teaching concerns and lack of collegiality cited above. Students are often times reluctant to participate in multi-disciplinary teams due to an aversion to complexity and lack of focus on their perceived objectives for the course/project. Faculty likewise may view multidisciplinary instruction to be a diversion and a barrier to achieving the objectives for the course as traditionally taught.

Rigorous Quantitative Assessment of Engagement

Assessment is necessary with a variety of stakeholders and is significant in the realm of engaged scholarship. Student impact is of paramount importance. Given the nature and goals of engaged

scholarship, however, evaluating the achievement of objectives can be difficult to get at in a standard course. Consider the following subset of possible goals for an engaged scholarship course: enhanced critical thinking, problem solving skills, leadership skills, project management, and metacognition. And these are just a few of the possible educational goals for such a course. To achieve quantitative assessment and evaluation in these areas is a difficult undertaking. Most assessment relative to engaged scholarship has been qualitative in nature – with student reporting wide spread satisfaction and perceived benefit from the courses.

Community partner assessment and evaluation needs to be undertaken as well. Clear understanding of the objectives, responsibilities and liabilities, with the partnering community is needed. Formalizing these agreements can be challenging and often requires significant revision throughout the project timeline. Given the potential of elevated community expectations for delivery of a product, or a process, special care is warranted. Regulatory environments, liability issues, funding and time constraints may limit what results are possible. Clear understanding between faculty and the community partners is required – perhaps in the form of a memorandum of understanding. Otherwise, the quest for ‘impact’ in the community has the potential to result in unmet expectations.

Long Term Community Champions and Communication (access to university resources)

An easily accessible and navigable interface for the potential community partners needs to be available. University resources should be clearly identified and updated appropriately. The community partners need to feel as if they are true partners in any undertaking. That begins and ends with communication, access to information, and a means to provide input and a sense of empowerment and voice to impact the project moving forward.

Institutional Respect, Buy-in and Support

It is important that those engaging in the teaching, research and scholarship associated with engaged scholarship feel as if their contributions are valued by the university, the college and the department. This overlaps with the building of a sense of collegiality for participating faculty, but also to lend credibility and a sense of professionalism in the eyes of the communities, students, and others outside the walls of the academy.

SUMMARY

Significant research exists which indicates that many of the skills and attributes required of engineers in the workplace can be facilitated by having students participate in ‘engaged scholarship’ in the form of service learning, coops and internships, studios design activities, and capstone projects. Penn State offers numerous opportunities for students to participate in such undertakings. However, there remain hurdles to greater and more effective implementation of engaged scholarship.

Despite the joint mission of universities to include teaching, research, and outreach as part of their work, many institutions and faculty see these missions as being disparate or even competing demands that must be effectively balanced and carefully managed to ensure that limited resources are best spent. At the same time, it is recognized that outreach and education can provide an unparalleled source of data for research. Research and outreach can serve as a laboratory for experiential learning that engages students on multiple levels. The challenge for faculty is to match and manage opportunities while tapping resources from multiple sources to

achieve simultaneous aims⁶⁰. This is the essence of ‘engaged scholarship’. There is a need for the administrative infrastructure to facilitate and nurture the goals of ‘engaged scholarship’. To date however, there is no generic framework available to describe how all of these activities combine in a self-sustaining way. An enhanced and inter-related ecosystem to facilitate these concurrent goals of the many participants would be most useful.

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