

# Serving with Engineering Skills within 15 Miles of Campus: The Scholars of Excellence in Engineering and Computer Science Program

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**Abstract**— The Scholars of Excellence in Engineering and Computer Science (SEECs) program initiated its first cohort of 20 students in fall 2009. Funded for two, five-year awards through a National Science Foundation (NSF) S-STEM grant, the interdisciplinary, multi-year, mixed academic-level program offers scholarships to students based on academic merit and financial need. The goals of the scholarship program are (1) to increase the number of academically talented, but financially disadvantaged students in the stated majors, (2) to assist students to be successful in their undergraduate education, and (3) to foster professional development for careers or graduate education.

A hallmark principle behind these goals is to build a broad scope of engineering and professional skills which include interpersonal communication, client-focus, and community-service, knowing technical skills are readily developed in the students' academic courses. The SEECs program is delivered through the activities of a zero-credit seminar. The SEECs seminar encompasses three components: engineering design, professional development, and personal development. Through the engineering design component, the mechanism for realizing the hallmark principle is achieved.

An engineering need of a non-profit community partner is identified, becoming the design project for the next two years for each new freshman class. The students become engaged in a long-term relationship with the non-profit community partner. The project provides a platform for exercising technical engineering

skills and practices. The relationship, the organization, the contact people, the served audience provide a human culture with which the students become entwined. Consequently, the client-focus attitude of business is fostered in the engineering and computer science students.

Unlike typical engineering semester-long projects -- or even year-long capstone projects, the incremental pace over two years allows students to mature in their understanding of themselves, of the project, and of the community they serve. Through the two years, the students use more and various types of interpersonal communications than in a semester-long project. Further, the students do not view the client and his/her needs as a convenience for their education. The students become invested in the goals of the non-profit since the project's understanding and conclusion become a shared focus between them.

In the following paper, the techniques and steps used to identify projects, build relationships, and align the students with a community need are described. To illustrate these points, aspects of the SEECs program and its community projects are presented. Finally, an innovative model for a project-based, honors-option for academically-talented students in SEECs majors based upon the practices used in the SEECs program is proposed.

**Keywords**—Honors programs, service learning, engineering education

## I. CHANGING A STUDENT'S WORLD VIEW

Higher education in the third millennium can be characterized by the attribute "student-centered." From learning modalities to retention efforts, universities are seeking approaches to have the students acquire learning, school loyalty, professional ethos, and personal growth actively, but latently, as a by-product of interactions with projects, events, peers, and professors. These changes are possible by moving the students from being simply involved to being committed. As the adage purports, "The difference between involvement and commitment is like ham and eggs. The chicken is involved; the pig is committed." For students truly to be the active agent in learning, retention, careers, and maturing, they must become committed to the activities.

On the learning aspect, college professors have a wide variety of teaching approaches to select in order to engage and immerse the students in a discipline directly. For instance, options like the flipped classroom [1] or project-based education [2] seek to have the student immediately involved with the content. Besides the learning advantages touted for such pedagogies, the students gain the added benefit of being an active learner rather than a passive learner.

Relative to retention and school loyalty, universities define programs, events, and seminars [3, 4] to engage the students beyond the classroom, providing a personal connection with the university. These efforts focus on the changing needs of the students as they mature through the baccalaureate years. Once again, the efforts are student-centered, allowing the students to personally maximize the benefit of the interaction.

Service learning has become a vehicle in higher education for promoting student commitment to their education, careers, and life. Service learning (as defined by The National Service-Learning Clearinghouse) provides the following definition for service-learning.

*Service-Learning is a teaching and learning strategy that integrates meaningful community service with instruction and reflection to enrich the learning experience, teach civic responsibility, and strengthen communities. [5]*

Through service learning activities the students now extend their commitment to a broader unit, the community. Hence, the student is given the opportunities to change from a passive learner into a committed citizen.

A final note to changing the student's world-view is to develop a shift in the student's focus from themselves into a focus on "the other." While the efforts of higher-education have been centered on the student and the benefits generated by that stance, developing and incorporating a customer focus into the student's perspective produces a commitment of a different quality. On engineering and business projects, professionals with a customer focus build organizations with a customer focus and achieve the benefits of such due diligence.

Customer focus includes several different aspects beginning with understanding the needs of the customer through to maintaining open and responsive communication

channels with the customer. One definition of "customer focus" is:

*The orientation of an organization toward serving its clients' needs. Having a customer focus is usually a strong contributor to the overall success of a business and involves ensuring that all aspects of the company put its customers' satisfaction first. Also, having a customer focus usually includes maintaining an effective customer relations and service program. [6]*

Every skilled analyst, attuned engineer, and productive sales representative, knows the first tenet of problem-solving is to understand the problem from the customer's perspective, and then to solve that problem. Building such a customer focus in students, however, requires a context which has actual repercussions outside the controlled atmosphere of a classroom. The need to build such a focus is expressed in desired employee cross-functional skill sets under such labels as "emotional intelligence" or as a "service orientation"; the charge to do so is set for higher education.[7]

## II. OVERVIEW OF SCHOLARSHIP PROGRAM AND SEMINAR

The Scholars of Excellence in Engineering and Computer Science (SEECs) program initiated its first cohort of 20 students in fall 2009. Funded through an NSF S-STEM grant, the interdisciplinary, multi-year, mixed academic-level offering awarded scholarships to students based on academic merit and financial need. SEECs is an opportunity for students in the majors of Biomedical Engineering, Computer Science, Electrical Engineering, Environmental Engineering, Industrial Engineering, Information Systems, Mechanical Engineering, and Software Engineering at Gannon University, Erie, PA, in the School of Engineering and Computer Science. The goals of the scholarship program are (1) to increase the number of academically talented, but financially disadvantaged students in the stated majors, (2) to assist students to be successful in their undergraduate education, and (3) to foster professional development for careers or graduate education. These goals are realized through the students' shared interactions within the SEECs seminar.

Students awarded SEECs scholarships are required to attend a seminar where specific development and learning outcomes are realized in a team-based, project-based approach. The challenging and engaging aspect of the SEECs program is this zero-credit seminar. The Personal and Professional Development Seminar ("the seminar") seeks to incorporate several concurrent goals. Three components—engineering design, professional development, and personal development—embody these goals. First, it is meant to promote a sense of camaraderie among all scholarship recipients, across all academic levels and majors. Second, it is meant to provide a multi-disciplinary experience to all participants. Finally, in keeping with the mission of Gannon University, the seminar has a strong service component. Design activities, occupying 50% of the scheduled time, are the primary tool utilized to effect the "multidisciplinary" and "service" goals. Other "just for fun" activities are used to enhance engagement. The seminar is built around a curriculum addressing the intellectual

growth of the scholars through the design project and the professional and personal growth of the scholars through planned activities. The four principle investigators of the grant complement this set of goals, components, and activities by serving as mentors, sounding boards, or contact points to assist the students through their baccalaureate years.

For personal development, activities selected impinge on the premises of a balanced lifestyle, embracing nine dimensions: Intellectual, Political, Spiritual, Cultural, Sexual, Emotional, Physical, Social, and Life Planning, thus fostering holistic development. The seminar does not reach every dimension, but strives to address the six dimensions: Intellectual, Cultural, Emotional, Physical Social, and Life Planning. [8] For instance, each semester has an assortment of activities such as stress management, conflict resolution, core-value recognition, opportunities for cultural / social events, and an end-of-semester dinner with speaker.

Besides personal development, professional development is enhanced through planned, class-cohort, specific activities, as well. The activities reflect the collegiate developmental phase a student is experiencing within their undergraduate years. Similar to the cycle of personal development activities shared among the four classes, all the students experience professional development activities. Every fall and spring a technical speaker offers a colloquium and every year an industrial tour is conducted. To complete the professional scope, attendance and project presentation at a professional conference is included for the junior-cohort as specified in the grant.

Through these various activities the students appreciate the balance necessary to achieve a truly successful life composed of personal and professional aspects in harmony. The seminar does not stress one development sphere to be more important over the other. Rather, self-definition of strengths and weaknesses, and acceptance and mediation constructs are emphasized through various inventory and awareness exercises through the four years. The maturation faculty typically seek in students is explicitly observed by each scholar as a reflection of the other cohorts: seniors can appreciate how novice freshmen are; freshmen can see how mature four years of education can make a senior.

### III. IMPORTANCE OF THE ENGINEERING DESIGN COMPONENT

Although explicit activities and exercises focusing on professional development and personal development (PPD) are part of the SEECs program, the engineering design component is the pivotal component of the seminar, providing a platform for employing, practicing and maturing in the skills of PPD. The engineering design component connects and builds not only engineering competency but also personal confidence. Emphasizing the service-learning aspect of the seminar, the design projects benefit regional non-profit organizations. Students learn from each other while working on a real-world problem. Hence, the learning becomes relevant and the scholars excel as they share the intellectual, problem-solving aspects of design for an organization valuing their contribution.

The seminar design activity is a modified version of a peer-mentoring and learning-community paradigm. All classes are

active in design at all times. Given any cohort, as freshmen, students are mentored by senior students in conceptual design - identifying a need, identifying key stakeholders, developing appropriate specifications, and proceeding through the phase of concept selection. As sophomores, these same students are led by juniors through the embodiment phase, with the year culminating in a finished (and produced) design. In year three, these junior students mentor the sophomore cohort in the embodiment phase, and in the final year, as seniors, these students mentor the freshmen in concept development. The entire SEECs population is thus continually engaged in design, with two design projects ongoing at any time - one in development by seniors and freshmen, the other in production by juniors and sophomores.

Design projects are selected in accordance with the mission of Gannon University, which implicitly includes service to the local community -- figuratively within a 15-mile radius of campus. Non-profit and community organizations in need of engineering assistance are contacted as potential sources of projects. Gannon University serves as a secondary source of projects which, while performed nominally for Gannon, have a broader impact on the community. Past projects have benefitted (1) Bayfront Maritime Center, (2) Gannon University, (2) Pennsylvania Sea Grant program, (3) Barber National Institute, (4) Habitat for Humanity, (5) C.H.O.S.E. N. (Christian Hospitals Overseas Secure Equipment Needs), and (6) the Pennsylvania Soldiers and Sailors Home. The design aspect of the seminar helps students of different academic levels to bond, but has limited effect on bonding the entire SEECs population, from freshmen to seniors.

### IV. QUALITATIVE BENEFITS GAINED BY STUDENTS

To assess the change the SEECs program and its design projects have on the students' world view, instruments, given each semester, record the sentiment of the scholars towards four dimensions: (1) Engineering environment, (2) Engineering identity, (3) Attitudes, and (4) Skills. Bielefeld et al. [9, p. 537] advocate that student learning efforts - which would include service learning -- reside in a space spanning similar dimensions. Beginning in fall 2012, the SEECs program surveys the scholars at the end of each semester with respect to these dimensions. (Initial results of the survey were given in [11].)

The survey ratings are based on a seven-point scale from seven (strongly agree) to one (strongly disagree). The mean for the past five semesters is given in Table 1; a chart comparing the individual means of the five semesters is displayed in Fig. 1. Over the semesters, the scholars have shown consistently a positive response to the value of the seminar towards influencing the students' perceptions.

Over the eight questions, the strongest responses - those whose means are essentially in the top percentile -- relate to the interconnectedness exhibited by working on the projects, namely Question 3 (6.25), Question 6 (6.28), and Question 7 (6.24). In these aspects, the students acknowledge gaining an opportunity to become more aware of diverse, inclusive thinking.

TABLE I. FIVE-SEMESTER OVERALL AVERAGES

Question Number	Overall, the seminar and its experiences ...	Dimension	Overall Mean FA12-FA15 (7 : Strongly Agree)
1	... have been satisfying	Attitude	6.11
2	... have increased my appreciation for the aspects of engineering design	Engineering Environment	6.20
3	... have increased my awareness of the interdisciplinary interactions of engineering	Engineering Environment	6.25
4	... have provided opportunities to assess my abilities and interest in my chosen major and career	Engineering Identity	6.16
5	... have increased my desire to be a graduate of an engineering and / or science program	Engineering Identity	6.12
6	... have allowed me to understand the impact of engineering solutions in a societal context	Attitude	6.28
7	... have redefined engineering as a helping profession	Engineering Identity	6.24
8	... have improved my ability to communicate effectively	Skill	6.18

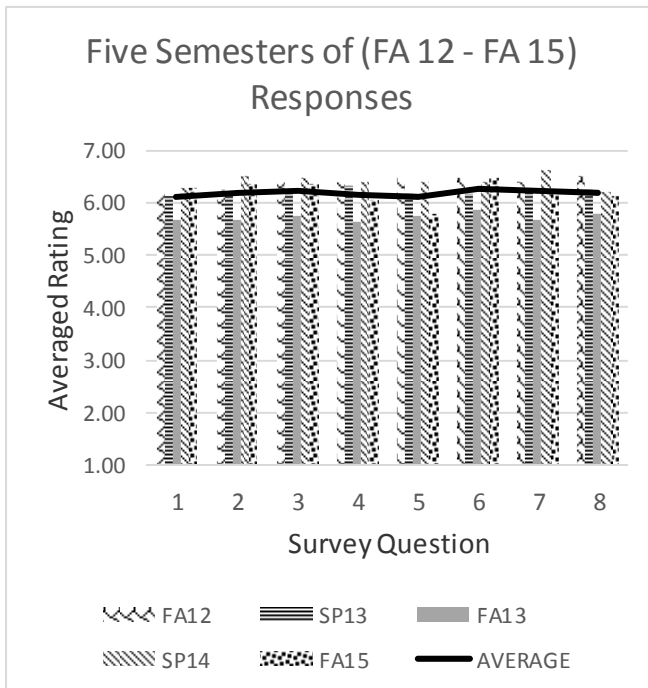


Fig. 1. Five-semester comparison of question means, relative to questions of Table 1.

## V. AN OPPORTUNITY FOR AN ENGINEERING HONORS PROGRAM

*Honors education is characterized by in-class and extracurricular activities that are measurably broader, deeper, or more complex than comparable learning experiences typically found at institutions of higher education. Honors experiences include a distinctive learner-directed environment and philosophy, provide opportunities that are appropriately tailored to fit the institution's culture and mission, and frequently occur within a close community of students and faculty. [10]*

Honors programs and honors colleges initiated their presence in America in the early 1920s.[12] The focus of such selective programs has always been to enrich the educational experience, to enhance the academic requirements, and to engage the student with the learning. The National Collegiate Honors Council (NCHC) identifies the modes for enabling learning through an honors program as a mix of five strategies: (1) Research and Creative Scholarship (“learning in depth”), (2) Breadth and Enduring Questions (“multi- or interdisciplinary learning”), (3) Service Learning and Leadership, (4) Experiential Learning, and (5) Learning Communities [13, p. 1]. As the professional resource and clearinghouse for honors communities, NCHC has identified 17 characteristics typical of a “basic, fully-developed honors program” covering aspects from early registration to governance [10]. (See Appendix for full listing.) The items delineate four factors considered within the definition, namely academics (#1, 4, 5, 6, 12, 15, 17), facilities and staff (#8 and 9), mission and governance (#2, 3, 10, 11, 14, 16), and extensional student benefits (#7 and 13). Regardless of the mix of learning strategies a program may have elected to deploy, the program itself would have taken a stance on each of the four factors – ideally on all 17 characteristics.

The history and successes of honors programs has been well asserted through the growth and diversity of such programs. However, such programs typically have a strong liberal arts influence in their delivery and administrative center. The dynamic and reflective thinking encouraged in honors programs is often lost in professional, technical courses as students strive to absorb all minutiae of the discipline. The SEECs program exhibits that such bifurcation of thinking and learning habits need not exist. Students tackling technical problems can gain the benefits of flexible and robust thinking in the way thinking processes are developed and honed in honors programs. With such habits, thinking “innovatively,” “creatively, and “outside the box” would be natural avenues for addressing customer-driven solutions.

Advocating for engineering honors programs which extend the structure and emphasis of the SEECs program is a natural progression of the evolution of honors programs. The structure, philosophy and modality of the program typifies an honors program. An engineering honors program does not minimize nor need to replace a traditional honors program at a university. What such a program will do is to provide the context for expressing all 17 characteristics. (The SEECs

program can catalog coverage of 11 characteristics in its current form (# 1, 2, 4, 7, 8, 10, 11, 12, 14, 16, and 17) with quasi-coverage of two more characteristics (# 3 and 13). Ultimately, the students will be better at incorporating a balanced, reflective life valuing discourse, judgment, and deliberation throughout all of their thinking situations. As it stands now, professional students are being implicitly taught that technical topics have a “right” answer and only humanities topics can be discussed.

Hence, an engineering honors program would benefit from incorporating the goals of the SEECs program as listed in Section II, particularly Goals 2 and 3. An engineering honors program would be a vehicle for institutionalizing Goal 1 within an university’s structure. Many institutions give “academically talented, but financially disadvantaged students” scholarships in order to secure their talent and success among their alumni as well as inviting the students into the privileged ranks of an honors program. An engineering honors program would enable the goals of the SEECs program and bring the benefits of the SEECs program to the totality of the university’s academically talented and engineering bound population.

The reality of problem-solving in any domain is one of exploration, investigation, understanding, and explanation. Simply because technical topics have equations and physical laws does not imply a sole solution exists, de facto. Once individuals develop the customer-focus to their problem-solving, then the need for balanced, reflective thinking becomes even more necessary. Sculpted programs similar to honors-programs’ environments and the SEECs program can enable this outcome.

#### APPENDIX: NCHC CHARACTERISTICS OF A BASIC, FULLY-DEVELOPED HONORS PROGRAM [14]

1. The honors program offers carefully designed educational experiences that meet the needs and abilities of the undergraduate students it serves. A clearly articulated set of admission criteria (e.g., GPA, SAT score, a written essay, satisfactory progress, etc.) identifies the targeted student population served by the honors program. The program clearly specifies the requirements needed for retention and satisfactory completion.
2. The program has a clear mandate from the institution’s administration in the form of a mission statement or charter document that includes the objectives and responsibilities of honors and defines the place of honors in the administrative and academic structure of the institution. The statement ensures the permanence and stability of honors by guaranteeing that adequate infrastructure resources, including an appropriate budget as well as appropriate faculty, staff, and administrative support when necessary, are allocated to honors so that the program avoids dependence on the good will and energy of particular faculty members or administrators for survival. In other words, the program is fully institutionalized (like comparable units on campus) so that it can build a lasting tradition of excellence.
3. The honors director reports to the chief academic officer of the institution.
4. The honors curriculum, established in harmony with the mission statement, meets the needs of the students in the program and features special courses, seminars, colloquia, experiential learning opportunities, undergraduate research opportunities, or other independent-study options.
5. The program requirements constitute a substantial portion of the participants’ undergraduate work, typically 20% to 25% of the total course work and certainly no less than 15%.
6. The curriculum of the program is designed so that honors requirements can, when appropriate, also satisfy general education requirements, major or disciplinary requirements, and preprofessional or professional training requirements.
7. The program provides a locus of visible and highly reputed standards and models of excellence for students and faculty across the campus.
8. The criteria for selection of honors faculty include exceptional teaching skills, the ability to provide intellectual leadership and mentoring for able students, and support for the mission of honors education.
9. The program is located in suitable, preferably prominent, quarters on campus that provide both access for the students and a focal point for honors activity. Those accommodations include space for honors administrative, faculty, and support staff functions as appropriate. They may include space for an honors lounge, library, reading rooms, and computer facilities. If the honors program has a significant residential component, the honors housing and residential life functions are designed to meet the academic and social needs of honors students.
10. The program has a standing committee or council of faculty members that works with the director or other administrative officer and is involved in honors curriculum, governance, policy, development, and evaluation deliberations. The composition of that group represents the colleges and/or departments served by the program and also elicits support for the program from across the campus.
11. Honors students are assured a voice in the governance and direction of the honors program. This can be achieved through a student committee that conducts its business with as much autonomy as possible but works in collaboration with the administration and faculty to maintain excellence in the program. Honors students are

included in governance, serving on the advisory/policy committee as well as constituting the group that governs the student association.

12. Honors students receive honors-related academic advising from qualified faculty and/or staff.
13. The program serves as a laboratory within which faculty feel welcome to experiment with new subjects, approaches, and pedagogies. When proven successful, such efforts in curriculum and pedagogical development can serve as prototypes for initiatives that can become institutionalized across the campus.
14. The program regularly assesses and evaluates program goals and learning outcomes as articulated in the National Collegiate Honors Council's definition of honors education and modes of honors learning, and as appropriate to the institution's culture and mission.
15. The program emphasizes active learning and participatory education by offering opportunities for students to participate in regional and national conferences, Honors Semesters, international programs, community service, internships, undergraduate research, and other types of experiential education.
16. When appropriate, two-year and four-year programs have articulation agreements by which honors graduates from two-year programs who meet previously agreed-upon requirements are accepted into four-year honors programs.
17. The program provides priority enrollment for active honors students in recognition of scheduling difficulties caused by the need to satisfy both honors and major program(s) requirements.

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