AC 2012-3522: SEEKING RELEVANCY, BUILDING EXCELLENCE: SERVICE-LEARNING IN THE SEECS PROGRAM

Dr. Karinna M. Vernaza, Gannon University

Karinna Vernaza joined Gannon University in 2003, and she is currently an Associate Professor in the Mechanical Engineering Department. She earned her Ph.D. and M.S. in mechanical engineering from the University of Notre Dame. Her B.S. is in Marine Systems Engineering from the U.S. Merchant Marine Academy. Her primary teaching responsibilities are in the solid mechanics and materials areas. She was awarded the 2012 ASEE NCS Outstanding Teacher Award. Vernaza consults for GE Transportation and does research in the area of alternative fuels (biodiesel), engineering education (active learning techniques), and high-strain deformation of materials. She is currently a Co-PI in an NSF S-STEM and ADVANCE-PAID grants. She is actively involved in outreach activities that introduce middle school students to engineering.

Dr. Theresa M. Vitolo, Gannon University
Barry J. Brinkman, Gannon University
Dr. Scott Steinbrink, Gannon University

Seeking Relevancy, Building Excellence: Service Learning in the SEECS Program, an NSF S-STEM sponsored project

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 computer science, electrical and computer engineering, environmental 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 SEECS seminar is structured around three components: engineering design, professional development, and personal development.

While the two development facets are valued, the engineering design component is the pivotal experience connecting and building not only engineering competency but also personal confidence. Emphasizing the service-learning aspect of the seminar, the design projects benefit regional non-profit organizations. The design activities pair the freshmen cohort with the seniors; the sophomores with the juniors. Through these pairings, the 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.

At this time, four design projects have been fostered by the SEECS seminar: two fully implemented, one in the design and deploy phases, and one in the requirements gathering stage. Each project supported different service organizations, complemented different distributions of majors, and required different technical competencies. Although structurally different, all four projects incorporate the aims of the SEECS program.

The following paper presents the methods used by the grant co-principal investigators (co-PIs) to identify potential stakeholders, to establish relationships with non-profit agencies, to recognize engineering needs, to define viable student projects, and to lead scholars in design tasks. Applied through the series of design projects, the methods enable the co-PIs to have the appropriate communication needed with the non-profit in the early-stages of project definition on through the final stages of deployment. The success of the methods is supported by student evaluations of their growth in understanding design and in appreciating their role in society. Finally, the potential for using the SEECS design approach as a model for a project-based, honors-option for academically-talented students in SEECS majors is discussed.

1 Introduction

One of the results of the American Competitiveness and Workforce Improvement Act of 1998[1] was the establishment of S-STEM by the National Science Foundation (NSF). In 2008, Gannon University's College of Engineering and Business was awarded an NSF S-STEM grant, specifically for academically talented students who exhibited financial need and wished to enroll in one of Gannon's engineering and computer science majors. The Gannon scholarship program was given the name Scholars of Excellence in Engineering and Computer Science (SEECS) in Award No. DUE-0806735.

The grant proposal specified three main goals of the SEECS Project:

1. Increase the number of academically talented, financially disadvantaged students enrolled in Gannon University's computer science and engineering programs, especially minority, female, and disabled students.
2. Through a program of scholarships and rigorous academic support, assist students to continue their education through graduation.
3. Foster professional development that prepares students for careers in STEM fields and graduate education.

To realize these goals, the co-principal investigators (co-PIs) envisioned a program structure and supporting activities to accomplish the following objectives during the duration of the scholarship project:

- Objective 1: Provide 20 scholarships per year for academically talented, financially disadvantaged STEM majors, especially those from underrepresented groups.
- Objective 2: Build a referral network arrangement between Gannon University, the Erie City School District, and the local U.S. Department of Education Talent Search program to identify and recruit financially disadvantaged students from underrepresented groups who meet SEECS scholarship eligibility requirements.
- Objective 3: Provide a program of academic and student service support that achieves a 90% year-to-year retention rate for SEECS scholars.
- Objective 4: Provide scholars with academic and professional development that prepares them for graduate school and/or employment in a STEM field.

One of the activities incorporated in the scholarship program to address Objectives 3 and 4 has been the community-based, team design projects. The following sections present the design projects already completed and those in progress. The methods used by the grant co-PIs to identify potential stakeholders, to establish and maintain relationships with the stakeholders, and

to select appropriate projects are also presented. Finally, details of how scholars are coached through the design process are discussed, as are future plans for the design effort.

2 Seminar Activities

The activities of the scholarship are conducted through a zero-credit required seminar, "The Personal and Professional Development Seminar." The design process methodology and related activities are included in the seminar sessions. The seminars seek to accomplish several goals including: promoting a sense of camaraderie among all scholarship recipients, providing a multi-disciplinary experience to all participants, and offering a strong service component.

In the SEECS seminars, freshmen students are mentored by senior students in conceptual design. These students are presented with an identified need and corresponding key stakeholders. The students develop appropriate specifications and begin the initial design process, ending the year with several potential design solutions. As sophomores, these same students are led by juniors through the embodiment phase. During this phase, a design is selected from the alternatives produced the prior year, the design is finalized, and then implemented.

The seminar features the design project which promotes the intellectual growth of the scholars, but the seminar also provides for the professional and personal growth of the scholars. Each semester 50% of the time is reserved for the design component, while the remaining time is spent on activities which nurture professional and personal growth. Additional details concerning the seminar can be found in an earlier paper by the authors.[2]

3 Service Learning and Design Projects

Service to the community is a major component of a Gannon education. In 2009-2010 Gannon students contributed over 70,000 hours of community service, with 32,200 occurring in academic service-learning courses.[3] The university has been expanding the number of courses utilizing service-learning. Complementary to this mission, SEECS implements a design component which offers scholars the opportunity to apply their STEM learning in support of a service-learning, community-based, team design project.

The Service Learning Office, established in May 2006, serves as a resource for the SEECS program to identify potential stakeholders and community-based projects. Non-profit and community organizations in need of engineering assistance are contacted by the faculty 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.

Paired with a community non-profit organization, the team of SEECS scholars identifies and designs solutions to STEM-related problems to aid the organization. Junior and senior scholars peer-mentor sophomores and freshmen, respectively, using what they learned in the classroom to solve a real-world problem. The mentoring-learning paradigm adopted and the structure of the seminar are explained in a previous publication.[2]

Design activities are the primary tool utilized to effect the "multidisciplinary" and "service" goals in the seminar; therefore, the selected community-based projects should have specific characteristics as outlined below.

- Ideally, knowledge required for the solution draws from all of the scholarship-eligible major fields, specifically the freshman cohort.
- The stakeholder need for a solution must not be immediate.
- The solution must be achievable in a two-year design cycle of 24 weeks of design effort.
- The scope of the project needs to embrace all phases of the design and deployment process.
- The project's level of visibility should entice students' interest.
- The stakeholder must commit to provide intellectual support; ideally the stakeholder will also provide monetary support.

Table 1 illustrates the potential partners, variety of projects considered to-date and the projects selected for pursuit. The development of relationships with the stakeholders is crucial to the reputation and sustainability of the program (to be discussed in Section 4). As in any partnership, it is important to understand the interests of every constituent. A description of the purpose of the non-profit organizations selected as partners follows:

- **Bayfront Maritime Center**
  - "Develop and implement unique, experiential, maritime themed educational, recreational and vocational opportunities for the community in a universally accessible waterfront facility".[4]
- **Gannon University "Gannon Goes Green" initiative**
  - Promotes environmental sustainability in accordance with the mission of the university and with Catholic teaching.[5]
- **Pennsylvania Sea Grant**
  - "Promotes the ecological and economic sustainability of Pennsylvania's coastal resources through research and outreach … focusing on the Lake Erie and Delaware River drainages of Pennsylvania".[6]
- **Barber National Institute**

- "Provide[s] children and adults with developmental disabilities and their families the education, support and resources needed to be self reliant, independent and valued members of their community".[7]

Table 1: Summary of organizations contacted and proposed projects

Contact Year	Organization (Stakeholder)	Proposed Projects	Status
2009	The AbilityOne Program (www.a1designchallenge.org)	AbilityOne Network Design Challenge	Potential
	Christian Hospitals Overseas Secure Equipment Needs (CHOSEN) Mission Project (www.chosenmissionproject.com)	Surgical light arms	Potential
		Incinerator for medical waste for third world countries	Referred for ME Senior Design project
	Soldiers' and Sailors' Home (www.pssh.state.pa.us)	Ramp for emergency evacuation of disabled residents	Potential
	Bayfront Maritime Center	Water flotation shoes	Potential
		Redesign boat ramp	**Selected as 2009-2010 Sophomore-Junior project**
		Off-the-grid classroom	Potential
	Gannon University	**Go Green bicycle-powered electrical generator**	**Selected as 2009-2011 project**
2010	Sea Grant Pennsylvania	**Cascade Creek flow diagnosis**	**Selected as 2010-2012 project**
		Semi-permeable membrane device holder and flow meter	Potential
		Bulb bouts for storm waters	Potential
	Regional Science Consortium (http://www.regsciconsort.com)	Device to remotely monitor frogs	Potential
	Barber National Institute	Shredding machines for paper recycling program	Potential
		Therapeutic swings	Potential
		Kit assembly assist	**Selected as 2011-2013 project**

The entire SEECS population is thus continually engaged in design, with two design projects ongoing at any time – one in conceptualization by seniors and freshmen, the other in production by juniors and sophomores. To date, four community-based projects have been selected, as presented in Table 1. Consideration of the students' knowledge base has been a key factor during the selection of the projects, specifically the major of the students involved during the conceptualization phase (Table 2). The four projects are described in the following sections.

Table 2: Correlation between selected projects and engineering majors

	Boat Ramp	Go Green Bicycle	Sediment	Kit Assembly

		Generator	Collector	Assist
Computer Science				√
Electrical Engineering		√		√
Environmental Engineering	√		√	
Information Systems				√
Mechanical Engineering	√	√	√	√
Software Engineering				√

3.1 Bayfront Maritime Center (BMC), Boat Ramp

The first project selected was the redesign and construction of a new ramp for kayaks and canoes to support the activities of the center. BMC supports various organizations (high schools, middle schools, scouts, YMCA, etc.) with educational programs that build small watercraft. The center uses a small ramp outside its building to place the watercraft in the bay and to retrieve them. In August 2009, the existing ramp was at the end of its useful life. Refer to Figure 1 to observe the condition of the ramp. The SEECS cohort was charged with the design and construction of a replacement ramp of better quality and longer life.

Figure 1: Ramp's condition at the beginning of the project

This first project followed a 1-year development sequence. In one semester, the students proposed two designs (Figure 2), provided several cost analyses, and met with the stakeholder twice. The designs were very creative and provided the stakeholder with additional functionalities that the existing ramp did not possess. For example, Figure 3 presents the idea of a floating dock in two different arrangements to facilitate embarking and disembarking.

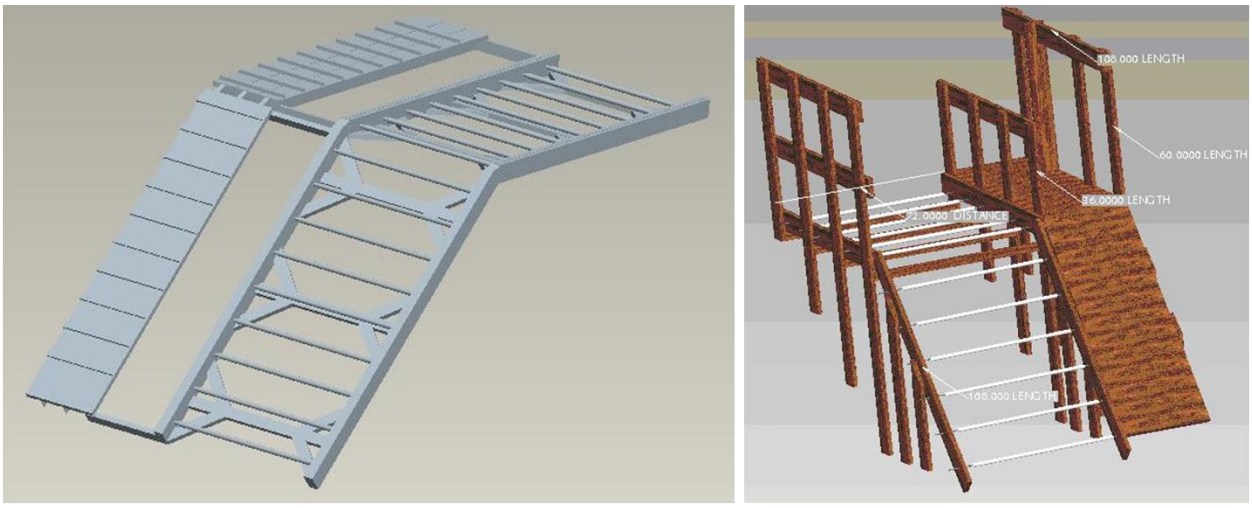

Figure 2: Proposed designs (student-generated images)

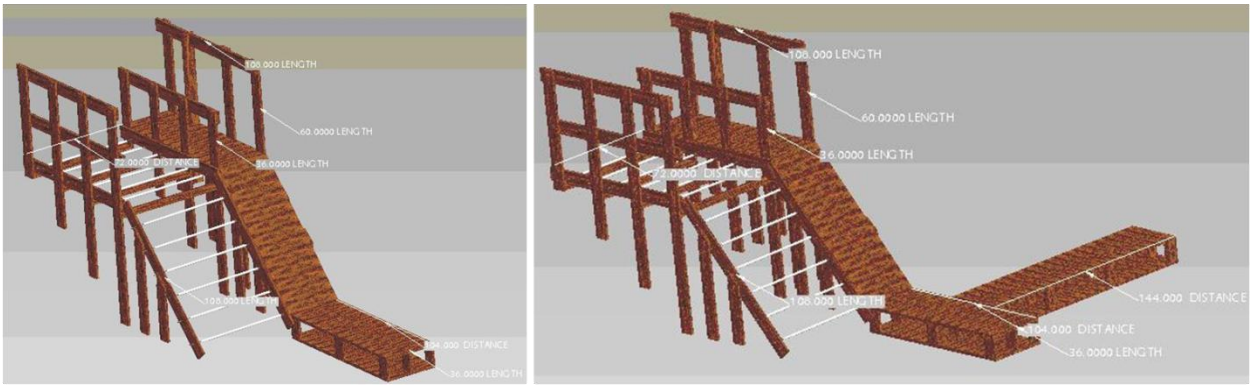

Figure 3: Examples of additional proposed functionalities (student-generated images)

As sometimes happens in real life, the stakeholder modified the requirements late in the process, based upon perceived availability of building materials at no cost. Consequently, a simpler design was required; the teams redirected their efforts. This iterative process resulted in a new design (Figure 4) which is much stronger and more durable than the previous ramp. The construction of the approved design was completed in spring of 2010 and the authors can report the successful use of the ramp for two summers.

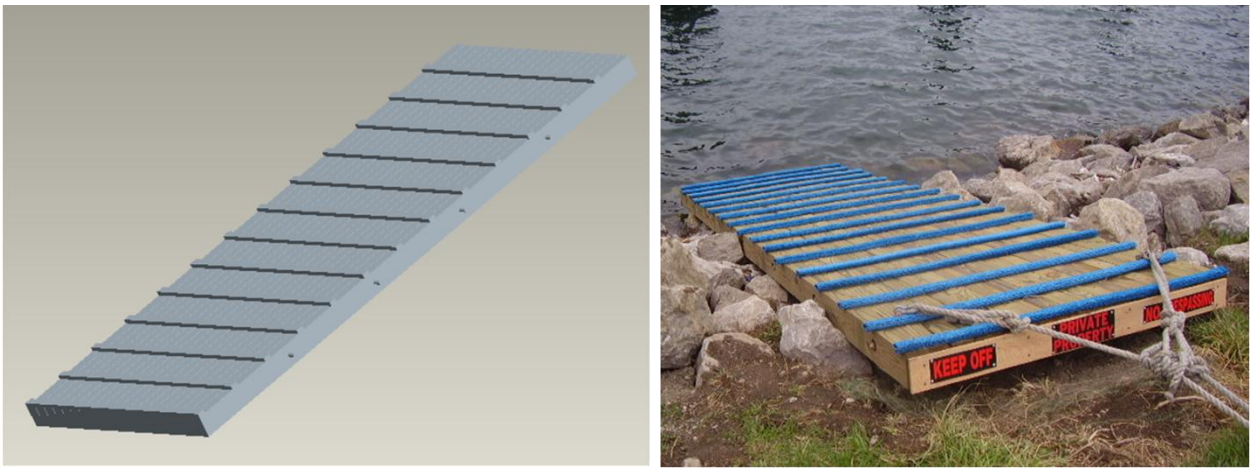

Figure 4: Design approved for construction and final product

3.2 Gannon University, "Go Green" Bicycle Generator

The second project undertaken by SEECS students was selected by the freshman students who entered into the SEECS program in fall 2009. This cohort of students chose to design and build a bicycle-powered electrical generator (Table 1). Initially, this project was not offered as a choice by the SEECS faculty members; it was instead student-initiated. The project was completed in the spring of 2011. The stakeholder for this project was Gannon University, specifically the *Gannon Goes Green* (GGG) initiative, a campus-wide effort to improve environmental sustainability. The mission statement of GGG is as follows:

> *As a Catholic institution located in a downtown urban environment at the edge of one of America's greatest natural resources, Gannon University has a unique opportunity to be a leading voice for principles of environmental sustainability. Our faith tradition challenges us to heed God's call for stewardship of the Earth, and to reduce our ecological footprint to create a healthier planet for present and future generations. The (greening committee) will serve as a recommending body that will position Gannon to be a leader in cost effective environmental innovation, making use of new technologies where appropriate, and to make academic and institutional policy connections between real-world environmental problems and potential solutions.*[5]

To date, GGG has completed a number of projects, including a feasibility study of green roofs for campus buildings, initiatives to save water and food in the student cafeteria, initiatives to improve reusability by gleaning and donating usable items left in the dorms by students moving out, improved recycling, switch to environmentally friendly cleaning products and many more, including the bicycle-powered electric generator.

The SEECS design utilizes a standard road bicycle attached to a stationary trainer device holding the bicycle in place. Unaltered, the trainer works as follows: as the cyclist pedals, the rear wheel of the bicycle is turned and in turn spins a drum to which is attached a magnetic resistance device. The magnetic device generates heat to dissipate the power provided by the rider. Altering the gear ratio of the bicycle by shifting gears provides variable resistance to match the goals and abilities of the rider. For this project, the magnetic resistance device was removed and replaced with a belt-driven 300 watt DC electric generator. The belt drive was designed for the purpose, along with other mechanical attachments. The electrical system was designed to match the capabilities of the generator, and included wiring, voltage regulator, battery for storage of excess power, power inverter, and fuses, switches and other safety devices. The sizing was chosen to coincide with a "best guess" of rider capabilities and with power needs of various candidate devices, such as a laptop computer or small television, and electric fan (Figure 5). To date, the device has served primarily as a demonstrator, used by students in the One Green World Café (an entrepreneurially-initiated, student-run coffee house on campus) who have used it to charge their cell phones while relaxing with friends, and it has also been used as a display item during campus-wide Open House events.

While the design was successfully completed at reasonable cost, the SEECS faculty members are of mixed feeling about student-initiated projects. Initially, the student buy-in to be had from selection of project seemed welcome, but in the end, the time spent in project definition detracted from time that could more productively be spent in concept generation. Thus, for the fourth project, initiated in fall 2011, students were presented with a specific project on which to work; no choice was offered.

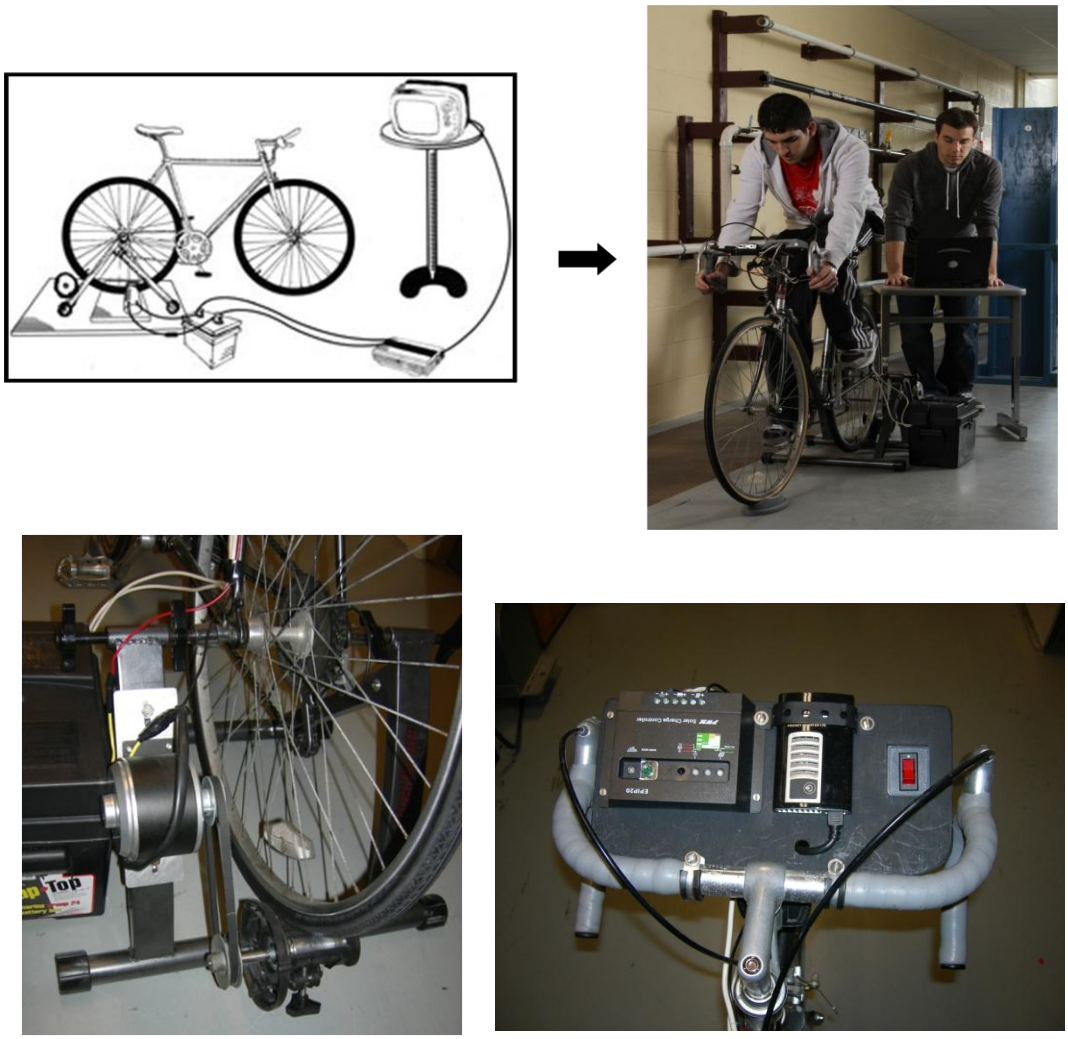

Figure 5: Bicycle generator model and students during demonstration

3.3 Pennsylvania Sea Grant, Sediment Collector

The project selected for the 2010-2012 design cycle was one amongst six choices presented to the students. This project supports the mission and activities of Pennsylvania Sea Grant. One of the current functions of Pennsylvania Sea Grant is to monitor the water quality of the streams and creeks that flow into Presque Isle Bay and Lake Erie. Urbanization increases the amount of impervious surfaces (such as roads, sidewalks, driveways, parking lots), ultimately leading to an increase in the amount of polluted runoff during rain events. The Environmental Protection Agency (EPA) states that polluted runoff is the number one water quality problem in the United States.[8] Increased runoff can lead to increased flooding, stream habitat destruction, and less pollutant removal due to decreased natural filtering capacity. The polluted runoff typically consists of pathogens, bacteria, nutrients, sediment, toxic contaminants, and debris.

Pennsylvania Sea Grant in interested in capturing suspended sediment from streams, during storm events, to assess for nutrients and toxins. Table 3 presents the chemical tests to be performed. Consequently, the analyses of the sediment will allow the stakeholder to determine the variety of harmful pollutants in the water and potential health hazards arising from the pollutants, and will help identify the sources of contamination.

Table 3: Details of suspended sediment chemical analysis

Tests	Definition or Classification	Volume Required	Comment
AVS/SEM	AVS: Acid Volatile Sulphide / SEM: Simultaneously-Extracted Metal	4 oz	Measures metal toxicity
Nitrogen and Phosphorus	Nutrients	4 oz	Leads to anoxia
Pesticides, PCBs	Pesticides include herbicides and insecticides; PCBs: Polychlorinated Biphenyls	8 oz	Pesticides kill organisms; PCBs are hazardous to human health
PAHs	Polycyclic Aromatic Hydrocarbons	32 oz	Carcinogenic
TOC, Oil and Grease, Metals	TOC: Total Organic Carbon	8 oz	TOC binds PAHs and Metals; Oil and grease can cause toxicity; Metals can cause toxicity and can be hazardous to human health

Currently, in order to collect sediment for the analyses, Pennsylvania Sea Grant personnel scoop settled sediment from stream beds where creeks and streams enter the bay. This method is not very practical nor efficient, hence, the need for a better mechanism to collect the required amount of sediment. The goal of the project is to create a device able to collect a minimum of two liters of suspended sediment for the required analyses.

Four different sampling sites were considered and Cascade Creek was selected as the location for the project. Cascade Creek presents a medium-sized stream whose flow is monitored regularly by local authorities. Further, several environmental studies have been conducted at this site providing a vast array of information supporting the project such as knowledge of its average flow rate and average depth during storm events.

During the first year of the two-year design cycle, students defined the requirements, visited the site, researched several possible ideas, and performed preliminary cost analyses. To date, two separate concepts have been presented by the students (Figures 6 and 7). The next steps in the process are proof-of-concepts, final design selection and construction. These actions are scheduled to take place during spring 2012.

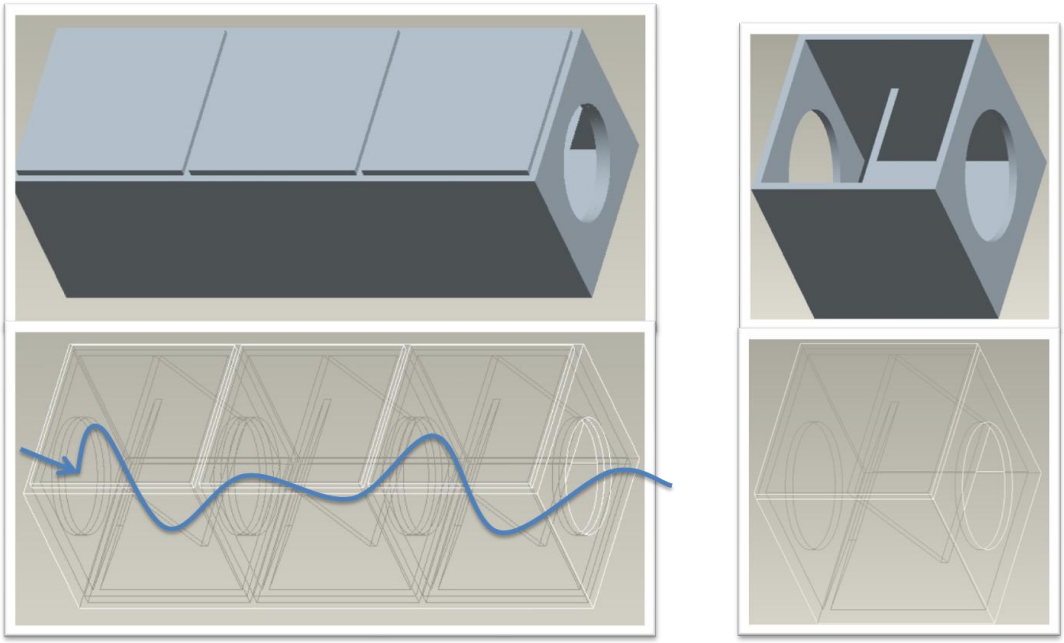

Figure 6: Proposed design # 1 for sediment collector (student-generated images)

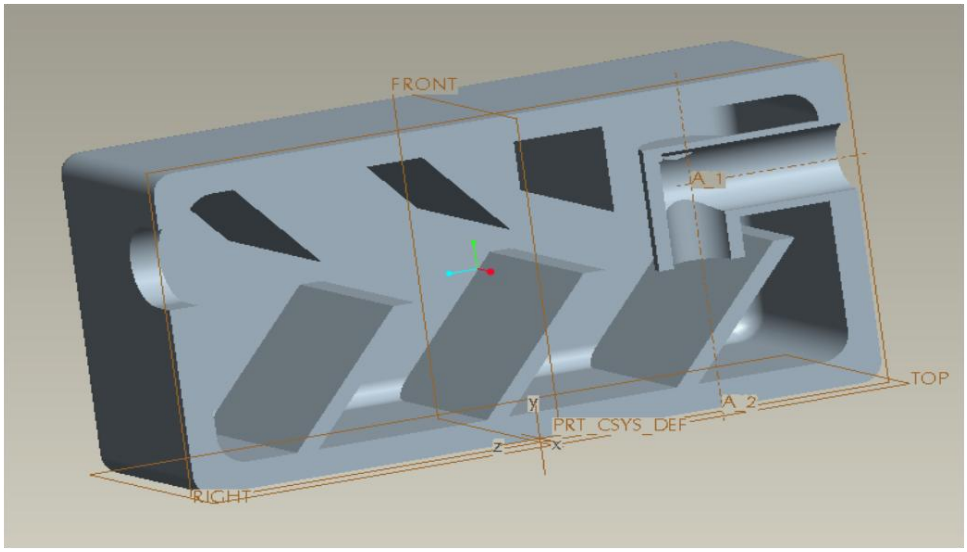

Figure 7: Proposed design # 2 for sediment collector (student-generated images)

3.4 Barber Institute, Kit Assembly Assist

For the 2011 freshmen cohort, the design project supports the vocational services of the Barber National Institute. Founded in 1952 to support children and adults with disabilities as well as to support their families, the institute has grown into a nationally recognized organization offering a wide range of services and opportunities for their population. Guiding their efforts, their mission statement captures the dedication and vision of the Barber Institute:

> *We are* "Making dreams come true." *We provide children and adults with developmental disabilities and their families the education, support and resources needed to be self reliant, independent and valued members of their community. In addition, we provide the professionals who serve them with world-class education and training*.[7]

The organization offers support to individuals and families beginning with early intervention services for infants and toddlers, proceeding through vocational training and employment placement, as well as residential and quality-of-life programs. No physical, mental, or social development hurdle is left unaddressed by the institute as it seeks to integrate and to enculturate its clients. Besides developmental support, the institute also is a center for education and training of professionals serving their population. Many of the programming approaches deployed by the institute are unique in their initiation and purpose. For instance, "Wheels in Motion" provides intellectual exercise for those suffering from cerebral palsy. A recent exercise allowed clients to participate in a geocaching activity which integrated retention of presented materials with recall of known facts about their home area.[9]

One of the ways adults with disabilities are supported through the Barber Institute is by providing vocational training and work-site opportunities. Clients proceed through an initial assessment, hard and soft skills training, individualized and specific site-training, and exposure to labor incentives. Once clients are prepared and qualified, they may move into supported employment services.

While in supported employment, a client is guided and supported by an employment specialist, a job coach. Clients (1) may become direct hires, (2) may be part of a service delivered to an organization, or (3) may do tasks at the Barber Institute Vocational Work Center (VWC). Direct hires continue to be supported by the Barber Institute in order for their work performance to continue to be acceptable and appropriate. Those employed as part of a service may be performing crew-based jobs such as landscaping or janitorial services. Those employed at the VWC handle assembly, piece-work assignments with guidance and supervision by Barber Institute professionals.[10]

Kit assembly is a common packaging task of the VWC site. A product may have a set of nuts, bolts, screws, gears, subassemblies – various parts of different dimensions, weight, pre-packaging – to be grouped into a kit. A business can either have a special-purpose kit-assembly machine engineered for their product, they can hire employees to individually pick the items and package into a kit, or they can negotiate a contract with the VWC to have the task accomplished off-site at the VWC.

The 2011-2013 project aims to build a device to assist a client handling a kit-assembly task. Some of the clients are intellectually handicapped and would benefit from a device automatically prompting them so that each part is selected and bundled and so that the correct number of the parts is selected. Other clients are physically handicapped and need mechanical support to assist in the holding of the bundle as it is incrementally packaged. Some have both limitations and would benefit from both support methods. The Barber Center staff would need to have an easily-configured interface to record the desired quantity of each type of part in the kit as the kit-orders vary on an irregular basis. Overall, the device must be safe for both the staff and the clients, should not be a permanent structure, but should be relatively mobile, so that it can be stored when not in use.

4 Project Development Methods

4.1 Relationship Building and Maintenance

The implemented curriculum for the SEECS program requires a constant flux of possible projects. Given the different engineering and computer science majors, the potential projects must be diverse in nature. The Office of Service Learning provided the referrals and networking opportunities between the SEECS faculty and the non-profit organizations that led to the majority of the projects listed in Table 1. As of fall 2011, the University Advancement Office has partnered with the co-PIs to identify possible projects, speakers and tours for the SEECS cohort. This office is interested in showcasing the service-learning, community-based projects to alumni which could result in future associations.

Once a referral is obtained, the co-PIs directly contact the non-profit to schedule a site visit in order to introduce the SEECS program, to evaluate the need of the non-profit and to decide if it is a feasible partnership. As stated in Section 3, it is imperative that the non-profit understands the structure of the SEECS program to ensure a successful relationship.

Through the first years of implementation, the co-PIs have come to recognize key elements to maintain productive partnerships that ensure the number and diversity of the projects:

- Clearly stated expectations from day one: Stakeholders must understand the timeline of delivery as a function of the students' educational experience.
- Constant communication with stakeholders: co-PIs act as the liaison between the students and the non-profit. Emails are constantly exchanged to clarify requirements, obtain additional information, schedule visits and provide progress summaries.
- Visit to sites: As part of the initial meeting, co-PIs visit the site to provide the initial evaluation of the project. The frequency of the visits will depend on the scope of the project. Once a project has been selected and during the conceptualization phase, students tour the site.

4.2 Project Selection

Over the course of the SEECS grant, the co-PIs have used several methods to select the design project. As outlined in Section 2, the SEECS seminar follows a two-year design sequence. The original plan for the design sequence was to have the freshman-senior group spend fall semester defining a project. The semester involved brainstorming project ideas, meeting with potential community partners, understanding needs, and finally, choosing a project to design and implement for the remainder of the two-year cycle.

Grant Year 1: In the initial year of the grant (2009-2010), two groups required a project: the sophomore-junior group and the freshman-senior group. The freshman-senior group was to follow the above process. However, since this was the first year of the grant, the sophomore-junior group had to work on a one-year design/development cycle. Neither the sophomore nor the junior class had been through the freshman design process, and the junior class had not been through the sophomore implementation process. With this cohort, the co-PIs decided to have both classes fully participate in both design and development. No formal peer-to-peer mentor relationship was realized within this group.

In order to assist in the abbreviation of the design/development process and because no relationships of this type with local non-profits had yet been established, two co-PIs made visits during the summer prior to the start of the academic year to several non-profit organizations. Several viable projects were identified by the co-PIs (Table 1) and three potential projects were selected for consideration by the sophomore-junior group, which consisted largely of mechanical engineering students. During the early part of fall semester one of the three projects was chosen by the group.

That same year, the freshman-senior group began the planned two-year cycle of design and development. The first task addressed was the selection of the project. The initial model of the SEECS seminar was to allow each freshman class, with mentoring from the senior class, to explore various project ideas, meet with potential community partners, and choose the two-year group project. This class chose to work with the Gannon Goes Green committee and produce a bicycle-powered electrical generator as the 2009-2011 project.

Grant Year 2: After evaluating seminar effectiveness following the 2009-2010 academic year, the co-PIs concluded more time must be allotted during the year for the freshman-senior group to begin to explore design alternatives. The co-PIs decided the SEECS scholars could not be asked to devote significant additional time to seminar activities, given that the seminar carries zero academic credits. The solution was to shorten the project definition timeframe in the future. To accomplish this, a modification was made for the 2010-2011 academic year. The co-PIs

again proactively visited potential community partners prior to the start of the academic year. The co-PIs then chose three potential projects and presented these for consideration to the 2010-2011 freshman-senior group. After much discussion, the Sediment Collector was chosen as the 2010-2012 project.

The effectiveness of this modified selection process was evaluated. With this group, the selection process also took significant time during the first semester. Many in the group favored one of the projects not ultimately chosen. Upon further consideration, the co-PIs determined the project favored by several freshmen could not be accomplished during the two-year cycle with the limited time available to design and implement a project. Despite this, several freshmen felt that they were not allowed to work on "their" project, but were required to work on an "assigned" project.

Grant Year 3: Based on these issues, for the 2011-2012 academic year, the co-PIs decided to chose the 2011-2013 project in advance and to present the project to the group as the project they would work on for the two years. This decision will be evaluated during the summer of 2012 to determine whether the process should be continued in the future.

4.3 Scholar Coaching through Design

A unique feature of the SEECS program lies in its use of upperclass students as mentors to underclass students. This peer-to-peer coaching is thought to be beneficial to both classes in each phase of the design. Seniors guide freshmen in project definition and conceptual design, while juniors guide sophomores in design embodiment. Projects defined by freshmen are then completed by those same students in their sophomore year.

Led and assisted by seniors, freshmen get a taste of the project definition end of the design process while seniors get a taste of the management role. Sophomores gain experience with "nuts and bolts" engineering, including putting relevant theories in practice, and are supported by juniors, whose technical knowledge is more mature. The support provided by junior students removes some technical constraints and allows sophomores to consider design solutions beyond those supported by their own immediate knowledge. Upperclass students benefit through development of a more mature understanding of the design process, as the act of mentoring requires the mentors to come to a firm grasp of the relevant tasks to be performed. In addition, all students get an exposure to a teamwork environment. One might perhaps consider the flow of project roles as an emulation of the typical technical career path: freshmen are like interns or early-career engineers/technicians, just learning the ropes, so to speak. Sophomores are like more advanced early-career personnel – learning to be technically proficient, but still requiring supervision. Juniors are like senior technical personnel, similar to a lead engineer, and seniors

fulfill a management role, similar to a project manager (though with limited oversight of the *entire* project).

An additional feature to be included in the design process model is to allow for an enhanced role for seniors. Senior students expressed a desire for more separation from the freshmen, in terms of role-playing. The concern is that the freshmen lack confidence enough to perform on their own, if senior students are available as a "crutch." Thus, senior students have suggested using their time out of class to review material for upcoming design sessions with the co-PI's with the intent that the seniors present the material in class. The seniors' hope is that in so doing, they will be seen by the freshmen more as authority figures than as co-workers to be shadowed. The SEECS faculty members adopted this suggested change as an experiment for spring 2012. This example shows the evolution of the mentoring roles based upon experience of students who have been through the entire mentoring model.

5 Future Plans and Lessons Learned

As the pivotal mechanism for achieving the goals of the NSF grant, the SEECS seminar is successful in achieving the goals. At the conclusion of the 2009-2010 and 2010-2011 academic years, SEECS scholars were given a survey and asked to rate different aspects of the seminar. A copy of the survey appears in Appendix A. Using a seven-point scale from one ("strongly agree") to seven ("strongly disagree"), the scholars rated satisfaction with the seminar, appreciation for the aspects of engineering design, and improved awareness of interdisciplinary interactions within the engineering field along with other items. On these aspects, the average scores were positive in the "mid-agree" level (where 1 = "strongly agree", 2 = "mid-agree") range.

The co-PIs have used different approaches to introduce projects to a freshman cohort, but the stakeholder interactions have remained constant through the four project launches. Maintaining good stakeholder relationships is critical – even more critical than maintaining good customer relationships in typical contractual arrangements. Here, buy-in from the stakeholders to commit time, information, and some funding is dependent upon the hospitality connections made and maintained as described here, and not dependent upon a financial arrangement. Integral to building a healthy relationship with the stakeholder is fostering an understanding by the SEECS scholars of the crucial reliance their design success has upon the communication with the stakeholder. Through the mentoring and support activities of the scholars, the students gain this understanding early in their academic efforts.

Financial support is crucial to the success of the projects. In the award supporting the SEECS seminars, no money was allocated for the design project. In retrospect, this omission was an oversight. To date, deployed projects have been supported by The Office of Service Learning,

Mechanical Engineering Department, stakeholders and, in a small portion, by the current award. The co-PIs have submitted a proposal for the NSF S-STEM 2011 cycle in which a specific budget line of $975 has been request for the design project supplies per year.

It appears from the positive aspects and enthusiasm generated by the SEECS program that the structure of the seminar could be a model for an Engineering Honors program emphasizing experiential learning. Academically qualified students would be encouraged to apply for admission to the proposed honors program. To encourage participation and defray student tuition expenses, outside sponsorship could be solicited, making participation in the honors program economically valued by the students and their families. The scholars would then also represent the outside sponsor as well as the university.

Design work related to non-profit projects would continue, as would peer mentoring and activities for professional and personal development. The value of the experiential component of the seminar should not be minimalized: students value the application of their abilities to a local need, the development of their professional potential, and the realization of the project. Projects are available and with the pace of the seminar, they can be achieved well. Faculty members would have to be trained and committed to the relationship-building practices identified here to ensure the connections with the stakeholders.

Gaining confidence from the seminar's success, the co-PIs are committed to the models of interactions used to support the project design and deployment activities. The interactions generate a close-partnership with the non-profit organization and a strong sense of ownership by the scholars for the work. The activities have been shown to be rewarding to the students, satisfying to the stakeholders, and potentially applicable as an experiential-learning structure for academically-strong students.

6 Acknowledgements

This work is supported by the National Science Foundation Award DUE-0806735.

7 References

1. American Competitiveness and Workforce Improvement Act of 1998 (P.L. 105-277).
2. K. M. Vernaza, T. M. Vitolo, S. Steinbrink, and B.J. Brinkman. (2011). *Scholars of Excellence in Engineering and Computer Science Program Phase I: Development and Implementation* [CD] in Proceedings of the 2011 American Society of Engineering Education Annual Conference, June 26-29, Vancouver, British Columbia, Canada.

3. Gannon University. News Archive, 9/3/2010, Gannon's Service Hours Top 79,000 [Online] Available: http://www.gannon.edu/admiss/undergrad/news/news_archive.asp
4. Bayfront Maritime Center. (n.d.) Bayfront Maritime Center | Bayfront Maritime Center [Online] Available: www.bayfrontcenter.org
5. Gannon University. (n.d.) Gannon University: Gannon Goes Green [Online] Available: http://www.gannon.edu/green
6. Pennsylvania Sea Grant (2000-2012) Pennsylvania Sea Grant - Erie PA [Online] Available: http://seagrant.psu.edu
7. Barber National Institute. (n.d.) Barber National Institute [Online] Available: http://www.drbarbercenter.org/
8. U.S. Environmental Protection Agency. Polluted Runoff (Nonpoint Source Pollution) [Online] Available: http://www.epa.gov/owow_keep/NPS/whatis.html
9. Bridging the Gaps Program. (n.d.) BTG Community Project Summaries [Online] Available: http://www.med.upenn.edu/btg/BTG_LECOM_Projects10.htm
10. Barber National Institute. (n.d.) Barber Industries: Our Facility – Erie PA [Online] Available: http://www.barberinstitute.org/BarberIndustries/index3.php

Appendix A: SEECS Seminar Participant Survey of Effectiveness

Scholars of Excellence in Engineering and Science
AY 2010-2011 Assessment

Name: _____ Today's Date: _____

Major? **CS** ☐ **ECE** ☐ **EnvE** ☐ **IS** ☐ **ME** ☐ **SE** ☐

SECTION (1) Seminar Activities

Provide a rating for the statements below that expresses your assessment.

	Strongly Agree 1	**2**	**3**	**4**	**5**	**6**	**Strongly Disagree 7**	**Not applicable**
Overall, the seminar and its experiences … has been satisfying	☐	☐	☐	☐	☐	☐	☐	☐
… has increased my appreciation for the aspects of engineering design	☐	☐	☐	☐	☐	☐	☐	☐
… has increased my awareness of the interdisciplinary interactions of engineering	☐	☐	☐	☐	☐	☐	☐	☐
… has increased my desire to be a graduate of an engineering and / or science program	☐	☐	☐	☐	☐	☐	☐	☐
The seminar and its activities…. … provided support for graduate entrance examinations.	☐	☐	☐	☐	☐	☐	☐	☐
… paid the testing fee for graduate entrance examinations.	☐	☐	☐	☐	☐	☐	☐	☐
… provided a program of industry contact through site visits, speaker series, shadowing, and / or informational interviews	☐	☐	☐	☐	☐	☐	☐	☐
… provided the opportunity for all scholars to have internship or co-op experience	☐	☐	☐	☐	☐	☐	☐	☐
… enabled connections with employers through professional organizations, conferences, career fairs, and personal contacts	☐	☐	☐	☐	☐	☐	☐	☐
… arranged for workshops with the Career Development & Employment Services Center for assistance in career planning, resume preparation, or job search	☐	☐	☐	☐	☐	☐	☐	☐
… provided opportunities for the scholars to build a sense of community among the classes	☐	☐	☐	☐	☐	☐	☐	☐

For First-Year Recipients and Freshmen **SECTION (2)** Advertising, Promotional, Marketing Activities								
I was introduced to the scholarship and its opportunities through …								
… information from my guidance counselor / adviser	☐	☐	☐	☐	☐	☐	☐	☐
… materials displayed in my school / campus	☐	☐	☐	☐	☐	☐	☐	☐
… postcards received at my home	☐	☐	☐	☐	☐	☐	☐	☐
… materials sent with my Gannon acceptance notice	☐	☐	☐	☐	☐	☐	☐	☐
… word-of-mouth contacts	☐	☐	☐	☐	☐	☐	☐	☐
… billboards in the area	☐	☐	☐	☐	☐	☐	☐	☐
SECTION: For Freshmen Only Freshmen Experience & Activities	**Strongly Agree 1**	**2**	**3**	**4**	**5**	**6**	**Strongly Disagree 7**	**Not applicable**
Freshmen sessions … … offered insights into the professional expectations and life of interns	☐	☐	☐	☐	☐	☐	☐	☐
… raised my awareness about stress and its management	☐	☐	☐	☐	☐	☐	☐	☐
… provided opportunities to assess my abilities and interest in my chosen major and career	☐	☐	☐	☐	☐	☐	☐	☐
… benefited from student mentoring of design aspects								
SECTION: For Sophomores Only Sophomore Experience & Activities	**Strongly Agree 1**	**2**	**3**	**4**	**5**	**6**	**Strongly Disagree 7**	**Not applicable**
Sophomore sessions …. … improved my understanding of the career-search process through career fairs	☐	☐	☐	☐	☐	☐	☐	☐
… raised my understanding of the value of emotional intelligence as a facet of professional competency	☐	☐	☐	☐	☐	☐	☐	☐
… benefited from student mentoring of design aspects	☐	☐	☐	☐	☐	☐	☐	☐
SECTION: For Juniors Only Junior Experience & Activities	**Strongly Agree 1**	**2**	**3**	**4**	**5**	**6**	**Strongly Disagree 7**	**Not applicable**
Junior sessions …. … increased my consideration of graduate school by enabling the graduate record examination	☐	☐	☐	☐	☐	☐	☐	☐
… raised my awareness about the variety of career options through career and graduate school fairs	☐	☐	☐	☐	☐	☐	☐	☐

… provided opportunities for networking with professionals and peers by conference participation	☐	☐	☐	☐	☐	☐	☐	☐
… reinforced design competency by providing mentoring	☐	☐	☐	☐	☐	☐	☐	☐
SECTION: For Seniors Only Senior Experience & Activities	**Strongly Agree** **1**	**2**	**3**	**4**	**5**	**6**	**Strongly Disagree** **7**	**Not applicable**
Senior sessions …. … provided support for job searching	☐	☐	☐	☐	☐	☐	☐	☐
... involving the Life Core Assessment exercise allowed me to reflect and / or balance my life	☐	☐	☐	☐	☐	☐	☐	☐
…involved with the FE exam or CSDE certification gave a valuable professional opportunity	☐	☐	☐	☐	☐	☐	☐	☐
… concerning participation in "Celebrate Gannon" was a good venue to showcase the community outreach conducted by the SEECS project	☐	☐	☐	☐	☐	☐	☐	☐
… reinforced design competency by providing mentoring	☐	☐	☐	☐	☐	☐	☐	☐
SECTION (3) Suggestions, Insights								
What suggestions do you have to build a greater sense of community among the classes?								
What suggestions do you have for enhancing interdisciplinary interactions?								
What one aspect increased your overall satisfaction with the seminar?								
What one aspect diminished your overall satisfaction with the seminar?								

Thank you for your thoughtful and timely remarks.