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House in a Box: Making an Interdisciplinary Capstone Work

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Abstract

Natural disasters create a set of challenges, especially in the area of providing safe housing after a destructive event. The HoUse in a Box (HUB) envisions a rapidly deployable, easily assembled, and permanent safe and sustainable housing solution in the aftermath of these events. At Clarkson University, a cross-disciplinary team of faculty from the Departments of Mechanical and Aeronautical Engineering, Civil and Environmental Engineering, Electrical Engineering, Engineering and Management, as well as from the Institute for a Sustainable Environment, have crafted a design and prototype synthesis exercise to build a HUB as part of the capstone course for all of these disciplinary programs. The course provides the student with an opportunity to put into practice the basic methodology and decisions surrounding sustainable design, leading to the building of a prototype of a sustainable house that can be packed into a box under the context of a company type of environment. Through several prior semester efforts, the team has had varying success in executing the development of the HUB--both as its own end, but also as a pedagogical problem-based learning exercise as well as meeting the varied ABET requirements. This presentation will discuss their lessons learned as they have tackled these challenges as well as the nature of the HUB project and its evolution.

STEM SCHOOL OUTREACH

Dr Lesa Carter

Cornell University

Abstract

Outreach to dis-advantaged youth is an important component of building an inclusive pipeline into engineering. Leveraging collaborations with programs such as Upward Bound and NY STEP that have already identified promising URM (underrepresented minorities), first generation, and otherwise disadvantaged, but academically promising teens, allows faculty to focus on developing and leading content while the outreach programs handle student logistics. We will describe one five-hour Upward Bound and STEP Saturday Academy event for middle school and high school. A faculty member organized and managed the fan car activity with the help of assistants. The fan car experiment included STEM and Humanities fields. Students learned physics, math, and engineering while building their own fan car cooperatively as a group. Many students had not taken physics and calculus, but they were thoroughly engaged in the activity. The faculty member had organized the activity that created a little competition with the fan cars students had built. The competition included cars that went the straightest the longest, cars that were the fastest for a designated length of time, and the most creative cars. After the competition, students were given the various types of careers involved in STEM fields. In addition, the Humanities (sociology, business, journalism) careers were discussed in relation to STEM fields. Based on students' chosen fields, they were encouraged to critically think about and creatively develop articles, work on business problems, and work on math and physics content that was applicable to their own lives. Students produced articles that focused on their discussions within their chosen fields. Their articles will be placed on STEM focused websites and they were encouraged to submit their work to their school newspapers. Importantly, the day was filled with trials and challenges for students, but as one group said, "We admired the resilience of our group."

ANTENNNAS AND SOURCE LOCATION: A SURVEY OF DIFFERENT METHODS

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Abstract

RF source location or direction finding is an important part and extremely relevant topic in an antennas course. Applications include location of the following signal types: emergency rescue signals, hoax GPS and other hoax electronic navigation signals, hoax rescue signals, power line and other interference sources, and illegal RF transmission. There are numerous methods of RF source location methods, the applicability of each one is a function of the source's frequency, and bandwidth. For example, an extremely directional antenna such as a Yagi or dish may be useful for locating narrowband VHF or UHF signals whereby the antenna the antenna’s positon is set for a peak response, whereas for LF signals, a more appropriate solution would be a loop antenna whose position is set to the null response. This paper will present our types of source location methods. These include the following: (a) a Yagi or other highly directional antenna mechanically set for peak response, (a) a steered phased array, (c) a loop antenna and (d) a phase array in conjunction with the MUSIC algorithm that can locate wideband spread spectrum signals. We will cover both the theory of each method, and how we have our students implement and then experimentally test each one.

The Bridges of Pittsburgh and Allegheny County

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Abstract
Throughout civilization is the well-known fact how many notable city and town locations were established and settled adjacent to water. The Shawnee long established an area within the Ohio River Headwaters where the Allegheny and Monongahela Rivers meet. Fort Duquesne was established by Robert LaSalle in 1669 only to be later captured and renamed Fort Pitt by the British in 1753 during the French and Indian War. Migration and growing population lead to finally establishing Pittsburgh in 1771.

As Pittsburgh grew, it became an important trade and transportation hub between river and railroad. Industry began with glass production followed by steel expanding Pittsburgh beyond where the three rivers meet establishing numerous bedroom communities.

Located on the western flank of the Appalachian Mountains, Laurel Highlands gives Pittsburgh its unique topography between river plain, steep to rolling hills, valleys, and plateaus. Bridges became the significant link bringing suburban communities together with the center city within the valley at the river confluence. Topography posed challenges towards achieving this good economic and social environmental balance for without bridges, everything may grind to a halt.

Timber and masonry were primary pre-industrial revolution construction materials proven effective, albeit limitations existed for span, length, and loads. Meanwhile, metals began transitioning towards construction applications notably with the first cast iron bridge built and opening in 1781 at Shropshire/Coalbrookedale, England. The first cast iron bridge in the US was built in Brownsville, Pennsylvania between 1836-1839 serving the original National Road. The Dunlap Creek Bridge eighty-foot arch span still serves today carrying US 40 across the creek.

Very few bridges existed in Pittsburgh during the early 19th century. Timber trusses were first used for the original 1818 Smithfield Street Bridge across the Monongahela River, then the only bridge and closest bridge to the confluence or point. Over time, the Industrial Revolution and transportation improvements resulted in greater loading soon rendering timber truss bridges obsolete. Noted engineers John Roebling and Gustav Lindenthal honed their skills and left their marks in Pittsburgh. In fact, at the same location, John Roebling built the second Smithfield Street Bridge, a wire rope suspension bridge in 1845 which was replaced with the current lenticular truss structure designed by Gustav Lindenthal between 1881 – 1883. As such, Lindenthal's bridge became the first steel bridge built in the US.

Downstream at the Point saw the construction of the first Point Bridge, a trussed eyebar suspension bridge in 1887. A second cantilever arch truss span replaced this original bridge when opened in 1927. The Manchester Bridge located opposite over the Allegheny River consisting of two Pratt trusses opened in 1915 establishing an all important link between the Point and opposite river banks. Another important link that became a trendsetter for another later

similar bridge is the Liberty Bridge that opened in 1928. This had a direct connection with the Liberty Tunnel that opened in 1924. The four lanes of traffic allowed for a unique flow of uninterrupted travel to Pittsburgh from its southern suburbs. These bridges met the demands of vehicular volume of the day but this was to change due to the following: Development of Point State Park emphasizing history, open recreation space and the landmark fountain at the very tip. The Interstate Highway System where plans called for then I-76, now I-376 and I-279 passing through Pittsburgh and the Golden Triangle. Slightly above the Point, the Fort Pitt Bridge and Tunnel (I-376) complex opened in 1959 followed by the Fort Duquesne Bridge (I-279) completed in 1963, opened for traffic in 1969 thus completing the interstate network through Pittsburgh.

Estimates include roughly 2000 bridges with a minimum eight-foot span within Pittsburgh and Allegheny County. This survey highlights the major bridges spanning the three rivers. Each bridge is unique with their own story. For example, traveling into Pittsburgh by way of the Fort Pitt Bridge requires motorists to go through the tunnel before exiting right at the start of the bridge giving one a dramatic immediate view of the Pittsburgh skyline day or night. The array and diverse bridge types can easily be seen as they cross the Ohio, Allegheny, and Monongahela Rivers as presented here while considering all roughly 2000 bridges that were built for the same purpose and function within Pittsburgh and Allegheny County.

INTERDISCIPLINARY ENGINEERING RESEARCH EXPERIENCE FOR UNDERGRADUATES

Dr Jikai Du
State University of New York College at Buffalo

Abstract
Undergraduate research not only can give students the opportunity to apply classroom knowledge to real world, but also help them to explore career directions. In this paper, an undergraduate student in Engineering Technology Department at SUNY College at Buffalo, conducted energy harvesting research on the project "Scattered Electric Power Conversion-Door Generator" during summer 2017. The project involves both mechanical engineering and electrical engineering research. During the research procedure, a faculty mentor established clear expectations with the student about work schedules and responsibilities. The faculty mentor also provided timely feedback to the student. In the project, the student learned to formulate and test a theoretical model, develop an experiment plan, collect and analyze experimental data, develop prototypes, acquire knowledge of the scientific literature in the related research area, and finish a final project report. In this paper, challenges and problems facing to both faculty and student are also discussed.

PERFORMING LEARNING: HOW E-PORTFOLIOS EMPOWER STUDENTS TO CLAIM DEVELOPING WRITING/COMMUNICATION (AND OTHER RELATED) COMPETENCIES

Dr Rick A. Evans

Cornell University

Abstract

In *What is Technical Writing*, W. Earl Britton (1965) states that "in all too many instances, at least in college, the student writes the wrong thing, for the wrong reason, to the wrong person, who evaluates it on the wrong basis." The wrong things, reasons, persons and bases for evaluation are many. However, what is common to all of these is that the writing, or more generally, the communication is inauthentic. In the typical college writing/communication classroom, students are not asked to produce genres current in a particular science/engineering context. Instead, they are asked to produce genres so generic, decontextualized "often imitating examples drawn from textbooks" that even professional practitioners find them difficult to recognize. They are not experts. Students write/communicate to demonstrate knowledge rather than share it. They are not writing to/communicating with someone who needs that knowledge. They write to/communicate with a professor who already knows more than they do (perhaps ever will). Finally, they are not evaluated on how well they have assisted or enabled someone else to get work done. Rather, the professor responds in terms of what she believes the writers/ communicators know. It is alarming to recognize that inauthentic writing/communication is regarded as instructional. It is downright frightening to realize that this article was written over fifty years ago and that our approach to writing/communication instruction has changed so little.

In both communication courses that I teach in the Engineering Communications Program (ECP) and in all the courses that I co-teach with engineering faculty across the curriculum, one of our primary aims is to make the writing/communication work that the students perform as authentic as possible. The majority of writing/communication that students engage in should attempt to perform some action, be context-bound always, exhibit design (structure and organization that serves a purpose), and foster the (creation and) presentation of identity. We will focus on a particular course, Organizational Communications for Engineers. We will illustrate how to realize authentic communication and the important role ePortfolios can play in facilitating the documentation, reflection and integration of student learning (Penny Light, et al., 2012). Indeed, it is through such documentation, reflection and integration that we can empower students to claim their own developing writing/communication (and other related) competencies.

First, some background about the course. Organizational Communications for Engineers is a senior-level communications course taught by ECP staff. It is one of many options for fulfilling the engineering communications requirement, a mandatory requirement of all undergraduate engineering students. While the shared focus is "the kinds of communication particular to an institution and/or organization," the course is routinely taught differently by different ECP faculty/staff. My approach is to teach it as a service-learning course. In cooperation with the office at our university that encourages _engaged learning,_ I typically solicit a number of organizations, I refer to them as "clients," that need someone to help them get real communication work done. The students work in teams of 3-5. They spend the first half-semester getting ready to perform that real communication work. For example, they learn about how to facilitate effective teamwork. They learn project management and communication is (especially in the sciences and engineering) almost always multimodal. They learn about concepts like genre, culture, gender, leadership as those concepts are related to organizations. Each team then selects an

organization and the project or projects that that organization has described. They spend the second half of the semester completing those projects. At the end of the semester, each student team provides their client with "deliverables," following a substantial (30 minute videotaped) presentation of those deliverables to that client.

The communication involved in working with these organizations/clients and in completing these projects is authentic. Also, at the end of the semester each team is responsible for collecting and presenting their semester's long work in an ePortfolio, portions off which may be shared with the client. It is important to understand that the ePortfolio is not simply a file for archiving their work. Rather, it is the genre through which each team will perform some action or actions. It is context-bound, our course. It requires that they consider the design or the structure and organization of the ePortfolio, both its affordances and constraints, as that design serves purpose(s). And, it is important that they use this ePortfolio to create and present not only a team identity, but the identities of each of the team members. In effect, the ePortfolio becomes the genre that allows students to perform their learning and to communicate that learning to their instructor in an authentic way.

Our presentation will involve three parts. First, we will provide a more detailed yet still brief description of the course along with corresponding handouts that articulate, for example, a new paradigm for understanding writing/communication, specific learning outcomes, and a rubric for assessing the ePortfolio. Second, we will offer a brief introduction to the Digication software. Finally, we will discuss a recent example of a student team ePortfolio highlighting how it has empowered the students to claim developing writing/communication (and other related) competencies.

USING A P3 FUNDED PROJECT AS PART OF A SENIOR DESIGN COURSE IN ENVIRONMENTAL ENGINEERING

Stefan Grimberg and Susan E. Powers

Clarkson University

Abstract

Over the past several years, students and faculty participated in a project funded through EPA's *People, Planet and Prosperity* (P3) competition. Undergraduate students participated in the project by taking the course identified as an interdisciplinary course or as part of their capstone design course requirements.

Anaerobic digestion (AD) is the preferable strategy to reduce the volume of food waste sent to solid waste landfills while simultaneously transforming the degradable organic compounds into valuable and sustainable products. Ammoniacal nitrogen, a product of the metabolism of microbes involved in AD, inhibits biogas production because at high concentrations it is toxic to the microorganisms responsible for producing the gas. To address this concern, the overall objective of this project was to develop an ammonia removal and recovery process for food waste digesters to increase the environmental and economic value of the AD system through higher biogas yields and fertilizer production. Through the first phase project through laboratory research and engineering design, the team determined the best method to remove ammoniacal nitrogen from the digester digestate and recover it as a cost-effective soil amendment for agriculture systems. During phase 2, students have been involved in scale-up design and will implement their design at a pilot scale system on campus for the coming school year [2018/19]. The system will then be evaluated over the course of one year [2019/20] to determine its net environmental and economic impact. From an educational perspective, students are involved in all phases of the design project including the construction in addition to laboratory studies, community outreach, data collection and analysis. Incorporating a research project within a class setting has been challenging in terms of balancing individual expectations, yet the overall learning experience has been tremendous. The presentation will focus on class structure, assessment of individual contributions, and project management. Lessons learned from this experience will certain be valuable when approaching another project.

Making Engineers Awesome Communicators: Cornell students practice sharing their work with the general public using social media, video, and presentation platforms in a new course, jointly developed by a Cornell University professor and WSKG Public Media professional

Julie A. Nucci, Nancy Coddington, David Syracuse, Anna Fang, and Samuel Bosco

Cornell University and WSKG

Abstract

If we want great engineering ideas to be realized, we need to create a new generation of engineers who think communicating their knowledge is just as important as learning and practicing it. Thanks to an Engaged Cornell grant received in 2017, a Cornell engineering professor and public media science communication professional teamed up to work towards this goal by developing a new engineering communication course titled ENGRG 3360: Developing Communicative Practice Through Transmedia and Community Engagement. In this course, which launched in the Spring 2018 semester, students are creating publically accessible presentations/videos, leveraging social media platforms to share their engineering endeavors, and mentoring high school students. We are using the PechaKucha format as an innovative presentation format to develop students' abilities to identify and communicate their key idea in a clear message tailored to a target audience. In contrast to the PechaKucha, which is an individual project, the video phase of the course is a team effort, with teams composed of high school students, undergraduates, and graduate students. Our high school population is a group of twelve local students spending their entire senior year on the Cornell campus exploring engineering. While students are comfortable with social media for social endeavors, it is paradigm shift for them to use these platforms for professional endeavors. To aid in this shift, students are required post technical content in two social media posts per week. We created course Facebook®, Instagram®®, and Twitter accounts, so students can either post to their own accounts or we post their content to the course account of their choice. The hashtag #CornellEngComm was created to track the content created. In this session, we will chronicle the course development, illustrate student work through student presentations developed for this class (some live, some recorded), share feedback from the mid-semester evaluation that tells us students value this content, and finish with a question and answer period.

BCI: TALKING WITH BRAINWAVES

Zachary Salim, Jennifer Barker, Jeremy Petrotto, Olivia Spellicy Sriram Subramanian, Megan Yoerg, Devon Rennoldson, Corey Ropell, Ian Kaminer, Arnav Matta

SUNY at Buffalo

Abstract

As an interdisciplinary group of nursing, cognitive science, speech pathology, computer science, computer engineering and mechanical engineering students, we are working to provide augmentative and alternative communication devices personally tailored to the needs of individuals who are paralyzed and do not have the ability to communicate verbally or through body language. Specifically, we are focusing our efforts on individuals with Amyotrophic Lateral Sclerosis (ALS). ALS presents a unique challenge in that the disease is progressive, meaning that an affected individual starts with the ability to communicate normally and ultimately ends up paralyzed and unable to speak. We have been able to follow the progression of the disease and are able to adapt the alternative communication technology to any individual's needs at any stage of the disease, meaning that our technology has become more complex with time, based on the individual's ability to move, speak, and communicate. Currently we are using an eyegaze system to track the user's eyes as they stare at a screen. We have developed an application that responds to the user's gaze and allows them to select on-screen buttons. These buttons in conjunction with external hardware allow the application to interact with the call light and eventually other peripheral devices such as the television, fan, and lights. This solution gives the user a simple way to communicate with those around them and have some control over their environment. While this solution is quite effective and versatile, our current direction is to move to a Brain-Computer Interface (BCI) device which would allow the user to control the environment more easily and more completely. Our research focuses on recognizing patterns in the brain waves in the motor cortex to allow the user to move the cursor on the screen.

INTRODUCING EXAMPLE PROBLEMS FROM WIDE RANGING INDUSTRIES INTO STATICS AND MECHANICS OF SOLIDS

Meredith Silberstein and Hadas Ritz

Cornell University

Abstract

The "Statics and Mechanics of Solids" course at Cornell University is the first required engineering course for mechanical engineering, civil engineering, biological engineering, and biomedical engineering undergraduate students. It covers both structures and mechanics of linear-elastic materials under simple loading geometries. In all, approximately 350 students take this engineering distribution course each year with 100-140 students per lecture. Because there are four different majors represented, the students have widely varying interests, many of them with little or no representation in a typical textbook for the course. In the past, this course has been taught through traditional style lectures and with homework problems assigned from the textbook. "This course has no relevance to what I want to do," is a frequent complaint the course has received in end-of-semester student reviews. In 2015 we received support from the James McCormick Family Teaching Excellence Institute at Cornell to revamp the course delivery. As part of this revision effort we added more professionally-oriented context to enhance student learning. We created this content as in-lecture group activities and homework video problems. The video problems were created in collaboration with professional practitioners whereas the activities were drawn from research and everyday life. In this presentation, we will discuss the process of creating the problems and then of editing them based on interacting with students as they tried to solve them. Based on student feedback, which has been positive about the inclusion of more concrete and discipline-relevant examples, but negative about the length, difficulty, and clarity of the associated problems, we are continuing to make improvements to this aspect of the course.