
AC 2012-4686: INTEGRATING ENTREPRENEURSHIP AND INNOVATION INTO AN ENGINEERING CURRICULUM THROUGH SERVICE LEARNING AND THE LIBERAL ARTS

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Integrating Entrepreneurship and Innovation into an Engineering Curriculum Through Service Learning and the Liberal Arts

ABSTRACT

This paper describes the way innovation and entrepreneurship have been integrated into an engineering curriculum through a year-long liberal arts seminar. This three-course sequence has “The City” as its topical focus, and it incorporates principles of entrepreneurship and innovation through course content specifically centered on these concepts through experiential learning in a service project, and through critical thinking and rhetorical analysis of students’ own research strategies using the Burkean parlor model of academic and professional conversation.

In Fall Quarter, students read texts, view films, and study other cultural products related to the concept of “The City.” They examine how depictions of entrepreneurs and industry illuminate our understanding of “City” and its connection to the American Dream—and the promises and perils associated with such a concept. In Winter Quarter, students study “The City” as an innovation center. The concept of creativity is examined as a social, collaborative idea, and students explore the history of the large city in which our institution is located. In Spring Quarter, students study the aesthetics of the city and analyze the rhetoric of public space. The relationship between art and commerce is explored, with historic and contemporary examples presented for analysis.

Students also complete substantial, self-directed research projects that require them to become familiar with current issues and recent trends in academic and professional conversations regarding their selected topics. Learning how to enter a field, ask the right questions, and determine its key “players” and important issues are hallmarks of the critical thinking skills cultivated in the traditions of liberal education. These same abilities also characterize the practices of entrepreneurs and innovators outside the academy. Service-learning projects have allowed students to work with government officials, community groups, and non-profit organizations – all actors that they will inevitably interact with once they become professionals. Completed projects have included the design and build of a community garden and rainwater catchment system, the construction of a solar food dehydrator, and a proposal to better define the entrance to and enhance the usability of a new urban state trail.

It is clear that the STEM disciplines (science, technology, engineering, and math) are important at this critical juncture in America life. But, as Columbia University historian Alan Brinkley has recently argued, “we would be equally impoverished without humanistic knowledge as well. Science and technology teach us what we can do. Humanistic thinking can help us understand what we should do.” A pedagogy based upon entrepreneurialism can help create a vibrant relationship between the liberal arts and engineering education, one that strengthens both disciplines as it better prepares students for the realities of 21st century economic life.

Introduction

Can entrepreneurship be taught? Until a few decades ago, the answer was usually “no.” Entrepreneurs were popularly understood to be a special breed of self-made man—an ideal closely linked to the “American Dream” and characterized by the optimism, ingenuity, grit, and risk-taking that marked the rise to greatness of such giants of industry as Henry Ford, Thomas Edison, Andrew Carnegie, and other innovators from modest backgrounds with limited formal education.

In recent years, though, entrepreneurial education has flourished. Today more than 2,000 colleges and universities in the United States, about two-thirds of the total, now offer at least one course in entrepreneurship.^[1] Despite its widespread growth, entrepreneurship education in higher education remains something taught primarily to engineering and business students, with an emphasis on finding opportunities, developing products, writing a business plan, and securing financing.

Yet learning this practical process for taking an idea into the marketplace may not be enough to equip students for the realities of real-world business contexts. As Peter Drucker noted in his 1985 book *Innovation and Entrepreneurship*: “Entrepreneurship is 'risky' mainly because so few of the so-called entrepreneurs know what they are doing. They lack the methodology.”^[2] Methodology is different from process: it is a higher-order concept, theory as opposed to practice. It means having a general knowledge of ingredients and culinary technique instead of using a specific recipe to cook a dish. It means having a collection of tools and the general knowledge of how to use each one instead of having a project kit with an instruction manual.

The emerging field of “entrepreneurship education” is still in its early stages. As other disciplines engage with it, its character will inevitably be altered, just as the nature of other disciplines will also be reshaped by their experiences with entrepreneurship.

With backgrounds in the liberal arts, the authors of this paper approach the teaching of entrepreneurship from a different perspective than colleagues in business and engineering. One of us holds a Ph.D. in American urban history, and the other has a Ph.D. in English, with a concentration in rhetoric and an undergraduate degree in political science. We are in the business of helping students develop their methodological tool kits through the liberal arts practices of reflection, insight, and synthesis. Using these practices, innovation and entrepreneurship have been integrated into an engineering curriculum through a year-long liberal arts seminar at Milwaukee School of Engineering.

This three-course freshman-level honors sequence has “The City” as its topical focus. Although we did not set out to create a course in entrepreneurship, the relationship between our intended goals and the tenets of entrepreneurial education became clear when we examined the content of our classes in connection with a grant application we became involved with that included faculty outside of our department. This paper summarizes the ways in which our freshman humanities sequence helps students develop

an entrepreneurial approach to their academic studies that is in marked contrast to the “employee” role students are accustomed to playing.

The three courses in the year-long honors sequence are interdisciplinary, combining humanities and social science subject matter with communication-intensive assignments and class activities. The courses are titled:

- Reading the City
- Writing/Righting the City
- Speaking the City

Over the year, students develop a construct of “The City” through readings that explore connections between the American Dream, entrepreneurship, and the urban environment. They research and produce papers, formal reports, and presentations on their own topics. Selection of topics is left completely to the students, as long as they are related somehow to “The City.”

Entrepreneurship is integrated into the courses at three different levels:

1. Topical readings, films, and other “texts”
2. Student research papers, reports, and presentations
3. Service learning experiences

Topical readings, films, and other “texts”

Students engage with many articles, videos, films, and books over the course of the year. Some are more related to the “city” topic than entrepreneurialism, but several are relevant to discussion of entrepreneurial concepts, as well:

- *Ragged Dick*, the Horatio Alger novel (published in 1867) that gave rise to the phrase “rags to riches” and captured/created a quintessentially American ideal of who an entrepreneur is.
- *The Devil and the White City*, by Erik Larson. This highly readable book offers a compelling historical account of how Chicago architect Daniel Burnham provided the driving force behind the World’s Columbian Exposition, better known as the 1893 Chicago World’s Fair. It is not only a tale of two cities—Chicago and the fair grounds known as “The White City,” a vanished place still astonishing to behold more than a century later (in photos, original film snippets, and contemporary YouTube animations)—but also a tale of two men who are entrepreneurs in very different ways. In a narrative thread running parallel to Daniel Burnham’s story, the book chronicles the criminal career of serial killer H.H. Holmes, who used the distracting chaos of the fair to lure and conceal the fate of his victims.

- “Make No Little Plans: Daniel Burnham and the American City” – Daniel Burnham also makes a return appearance in the third course, which emphasizes city architecture and the rhetoric of public space, in this video produced by PBS about Burnham’s career as an architect and pioneering urban planner.
- *The Fountainhead* – the Ayn Rand film about an architect who refuses to compromise the integrity of his vision.
- *The Naked City* – the 1948 film noir classic that captures the grit of mid-twentieth century New York City.
- *Invisible Man* – Ralph Ellison’s groundbreaking novel on work, race, and identity in twentieth-century New York City.
- *Making Milwaukee Mightier: Planning and the Politics of Growth, 1910-1960* – this work, by John M. McCarthy, documents the relationship between public policy and economic growth in the city of Milwaukee throughout the early to mid-20th century.
- *The Selma of the North: Civil Rights Insurgency in Milwaukee* – Patrick D. Jones’ riveting account of how race was lived in twentieth-century Milwaukee.

Stemming from such readings, we have also tried to have our students consider questions of history, politics, public policy, and economics as we discussed the concept of the city. Using the works of such renowned scholars as Mike Davis (*Planet of Slums*), David Harvey (*The Condition of Postmodernity*), Thomas Sugrue (*The Origins of the Urban Crisis: Race and Inequality in Postwar Detroit*), and Jefferson Cowie (*Capital Moves: RCA’s Seventy-Year Quest for Cheap Labor*) to answer these questions, students grappled with the realities of deindustrialization, white flight, and the mobility of capital – as well as the policies that had fostered such developments

More generally, the readings for the honors program have allowed us to talk about things like Leadership in Energy and Environmental Design (LEED) rating system, alternative energy sources, and the mechanics behind the infrastructure of things like high-speed rail. We read such authors as William McDonough (“Design, Ecology, Ethics and the Making of Things”) and Brenda and Robert Vale (“Principles of Green Architecture”). Our students were ultimately heartened by the fact that their desire to be environmentally responsible professionals could potentially lead to a good job in a high-growth field.

Student research papers, reports, and presentations

Entrepreneurs need to tolerate risk, which translates into a concept similar to what Romantic poet John Keats (who wrote “Ode to a Grecian Urn”) termed “negative capability”: having the ability to tolerate “uncertainties, Mysteries, doubts, without any irritable reaching after fact and reason.” Learning to tolerate ambiguity is an essential

skill for 21st-century engineers—for anyone, actually, whose job requires them to be capable of synthesis and meaning-making.

In addition to learning content that describes entrepreneurial traits and pathways, students also learn to practice habits of engagement that are not only central to academic inquiry in the liberal arts but are also, coincidentally, characteristic of the way entrepreneurs recognize and act on opportunity.

The first course in the year-long honors sequence introduces students to the concept of “The Burkean Parlor,” the metaphor created by legendary literary critic Kenneth Burke to describe academic/professional conversation ^[3]:

Imagine that you enter a parlor. You come late. When you arrive, others have long preceded you, and they are engaged in a heated discussion, a discussion too heated for them to pause and tell you exactly what it is about. In fact, the discussion had already begun long before any of them got there, so that no one present is qualified to retrace for you all the steps that had gone before. You listen for a while, until you decide that you have caught the tenor of the argument; then you put in your oar. Someone answers; you answer him; another comes to your defense; another aligns himself against you, to either the embarrassment or gratification of your opponent, depending upon the quality of your ally's assistance. However, the discussion is interminable. The hour grows late, you must depart. And you do depart, with the discussion still vigorously in progress.

This “parlor” metaphor illustrates the real-life purpose of academic research: to understand enough about both the topic under discussion and the people who are currently talking about it to enable the writer to contribute something of legitimate value to the conversation.

Three class periods are also spent viewing and discussing two video clips that introduce students to the entrepreneurial nature of self-directed learning.

The first clip is an interview (video link: <http://www.youtube.com/watch?v=y-7gWsoXtUw>) with Steven Chu, current U.S. Secretary of Energy and winner of the 1997 Nobel Prize in Physics. ^[4]

In this interview, Chu describes how “devastating” it was to be told as a young scientist at Bell Labs that he could do anything he wanted, “take your time,” and that great things were expected of him. It’s much more “cozy,” he says, to be given a problem and to be told what to do. It’s hard to learn how to ask the right questions or how to enter a new field (molecular biology, for Chu) and become conversant enough to understand the important issues and current research. But that environment of freedom and the self-directed learning strategies Chu was forced to devise are what eventually led him and several of his Bell Labs co-workers to win multiple Nobel Prizes. Says Chu:

When most people think of industrial labs they think of, “Oh, you’re making better widgets. You’re making something that’s going to be good for the phone system.” Now, ultimately, that’s true. But at Bell Labs in that time—this is in 1978—allowed a small fraction of us—fifty, sixty, eighty—to do whatever we wanted; really to do whatever we wanted.

So I joined Bell Laboratories. My department head said, “Steve, you can do whatever you want. It doesn’t even have to be physics. All we ask is that you don’t go to a high-energy accelerator and do high-energy physics, because that would be hard on the stockholders.” (My thesis project, and when I was working as a post-doc, addressed a high-energy physics problem.) He said, “And by the way, don’t do anything immediately. Spend six months. Talk to the people around the labs, and just keep an open mind.” This was a devastating experience for me, because of the freedom to do whatever you want and being told, “Don’t do what you think you want to do now, but explore.” So I spent some time exploring and thinking. And there, I really felt pressure, because he would say, “We expect great things out of you.” I didn’t want to hear that. It’s much nicer to have a little problem to work on; it’s very cozy.

But it did have a real influence on me, because it got me in that mode of going and talking to people outside of my field. When I finally started doing things at Bell Laboratories . . . and I started, first, in an area that was in condensed matter physics that I knew nothing about, but using techniques in my old field, atomic physics and laser physics. But it got me into the mode of, “I’ve got this crazy idea.” I’d go to some colleague in Bell Laboratories and say, “How does this sound?” And they would tell me, “No, this is the stupidest thing I’ve heard,” or “Yeah, maybe you have something there.” It set the tone for what I’ve done for the rest of my life—collaborating with people, especially outside my local expertise. It was a wonderful experience.

I also should say, in the years I was there, ’78 to ’87—there was an economic slump in the mid-seventies; Bell Labs just started hiring people—and there were a group of us, maybe a few dozen, two or three dozen, and we all were young, energetic, bright-eyed, bushy-tailed. We were all being put in this position: “Do something important. Here are the resources of American Telephone and Telegraph System. We expect you to do something wonderful.” We were there at night. We were there on the weekends. We knew what each other’s cars looked like, so we knew who was in there, let’s say, on a Saturday or Sunday. We would party together. [Looking back,] I think either five or six of us [later] got Nobel Prizes. Over a dozen are in the National Academy of Sciences. It’s like this: we all were growing up together. And we had these really wonderful senior scientists there as well.

It was a remarkable period of time. Everything was exciting, and something would come along that was not in my field, and I would say, “Wow, this is really interesting.” We’d go in, we’d discuss it. People would jump fields, or jump

areas. There was this feeling of the excitement of the science, that even though we were doing *this*, it was all right to move and do *that*. You wouldn't be considered a failure because you gave up this, because something else even more exciting came along, either from your own laboratory or from a colleague's lab, or from the outside world.

The second clip is Steve Jobs' 2005 Stanford commencement address (here is the link: http://www.youtube.com/watch?v=Hd_ptbiPoXM).^[5] In this speech, Jobs talks about dropping out of college in his freshman year and how, once he was free of the need to take required courses, he decided to take a calligraphy course:

I learned about serif and sans serif typefaces, about varying the amount of space between different letter combinations, about what makes great typography great. It was beautiful, historical, artistically subtle in a way that science can't capture, and I found it fascinating.

None of this had even a hope of any practical application in my life. But ten years later, when we were designing the first Macintosh computer, it all came back to me. And we designed it all into the Mac. It was the first computer with beautiful typography. If I had never dropped in on that single course in college, the Mac would have never had multiple typefaces or proportionally spaced fonts. And since Windows just copied the Mac, it's likely that no personal computer would have them. If I had never dropped out, I would have never dropped in on this calligraphy class, and personal computers might not have the wonderful typography that they do. Of course it was impossible to connect the dots looking forward when I was in college. But it was very, very clear looking backwards ten years later.

Three class sessions to view and discuss these videos is a time investment up front to help students understand the "entrepreneurial" nature of academic scholarship. Instead of being assigned a project, students must learn to ask the right questions and find problems "out there" that need to be worked on. They need to figure out which problems are intriguing to other people, a process akin to the way an entrepreneur identifies opportunities. And they are encouraged to cultivate primary research sources in addition to secondary sources, so that they will be speaking to local officials, company representatives, and other stakeholders associated with their project topics.

Service learning experiences

Students in the MSOE honors program also complete substantial, self-directed service-learning projects, which allow them to work with government officials, community groups, and non-profit organizations—all actors that they will inevitably interact with once they become professionals. Completed projects have included the design and build of a community garden and rainwater catchment system, the construction of a solar food dehydrator, and a proposal to better define the entrance to and enhance the usability of a new urban state trail. Partners have included:

- The Amaranth Bakery and Café: Located on the Northwest side of Milwaukee, the café anchors a block undergoing tremendous revitalization. Honors students have worked with Dave Boucher, the café owner, on a community garden and rainwater catchment system. The garden provides Dave with fresh ingredients for his bakery products – and the rainwater catchment system, which provides water for the garden, has become a prototype for similar projects in the Milwaukee metropolitan region.
- The Victory Garden Initiative (VGI): This non-profit provides assistance for those wishing to enter into the world of urban agriculture. Honors students have worked with VGI on a solar food dehydrator, a structure that dries out produce and allows it to be stored for long periods of time. This project has great entrepreneurial potential, and a second group of students are currently working on a new model.

Such projects place students directly within the urban fabric of the city of Milwaukee, allowing them to really experience life in a city. And after going through proper governmental channels – and after consulting extensively with community members – these students were able to see these service-learning projects through to completion. It is our hope that our students come out of these classes excited about working in cities – and interested in pursuing careers in “green” technologies.

Most importantly, all of these projects contained an entrepreneurial component. VGI, the community partner on the project, would like to work with the MSOE students to produce such mechanisms for sale. Future incarnations of the class may work to devise marketing strategies for these dehydrators – or they may work to improve upon the design of the product. With the Amaranth Bakery and Café project, MSOE students are not only working with an entrepreneur (Boucher himself) on a regular basis, they are also producing systems that have tremendous entrepreneurial potential. This year, for example, we have taken on the Milwaukee YMCA as a “client” – and our students are helping them to design and build a rainwater catchment system and a community garden.

Our students’ training as engineers has begun to give them the skills necessary to complete such projects; our classes give them the context as to why such projects are possible in twenty-first century Milwaukee, and why these endeavors could become valuable assets for those in the surrounding community. This is ultimately the point of our program: to allow the students to make these connections between engineering, entrepreneurialism, and the world in which they live and work. Here, the liberal arts, along with a commitment to service learning, has proven to be a useful tool to help young people make these connections between context, education, and innovation (see attached syllabi for the ways in which we’ve tried to help our students make such connections).

Conclusion

What we have done in our liberal arts honors sequence should be scalable to any discipline. Below are key points for student learning in any course that integrates

entrepreneurship and innovation into the subject material. Like Steve Jobs and Steven Chu, students should be encouraged to do the following:

1. Cast a wide net. Keep up with what is happening in your field and in the world generally.
2. Actively seek out problems to solve or areas opportunity where you would be the first person to do the particular type of work you are doing. Even freshman students can find *something* new to add to a conversation.
3. Figure out who has been talking about this problem or working in a similar area.
4. Get up to speed on the conversation of the field(s) regarding this topic so far.
5. Do your own original work. Research, write, and develop your product.
6. At the same time, begin entering the conversation of the field yourself, with small and manageable utterances.
7. Build your network(s) of colleagues, “customers,” and distribution-channel gatekeepers/managers both inside and outside your home field.
8. Build your “brand” by exploring new applications for your topic area—either by importing technology, techniques, or theory from other fields/domains to your own or by exporting the technology, techniques, or theory from your own field/domain to others.

It is clear that the STEM disciplines (science, technology, engineering, and math) are important at this critical juncture in American life. But, as Columbia University historian Alan Brinkley has recently argued, “We would be equally impoverished without humanistic knowledge as well. Science and technology teach us what we can do. Humanistic thinking can help us understand what we should do.” A pedagogy based upon entrepreneurialism can help create a vibrant relationship between the liberal arts and engineering education, one that strengthens both disciplines as it better prepares students for the realities of 21st century economic life.

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APPENDIX

The following documents are the master syllabi for the three freshman honors courses taught across the first year (fall, winter, and spring quarters). Edited sections (in red) reflect changes made after the course ran for the first time.

DOCUMENT 1

GS 1010 Honors Seminar I – City as Text – “Reading the City” (humanities focus)

4 credits 4 - 0 - 4

Prerequisite: enrollment in the Honors Program

Students will explore the “city as text,” learning to “read” the city. Readings from humanities disciplines about the concept of “the city” are included, and film will be used as a supplement to students’ reading. Students will write papers in response to their reading and service-learning experience; the final paper will be persuasive and include research from primary and secondary sources.

Outcomes

Upon successful completion of this course, the student will be able to

1. write unified, coherent, emphatic, and well-organized essays that include a clear thesis and, in some form, an introduction, a body, and a conclusion
2. understand basic rhetorical concepts, including ethos, pathos, and logos
3. work with sources at the college level. This includes discerning quality of sources, identifying which sources are more authoritative within a given rhetorical context, avoiding plagiarism and copyright infringement through awareness of ethical and legal constraints, and incorporating sources appropriately and effectively in students’ own writing

4. demonstrate an ability to engage in critical thinking through close reading and analysis of texts and making connections between course readings, personal experiences, current events, and personal values and beliefs
5. understand the concept of a “city” from a humanities perspective and become ~~aware of issues specific to that concept~~ familiar with the mythology, legend, imagery, and rhetorical constructs surrounding that concept.
6. develop awareness of social responsibility and interpret personal experience through a service-learning project
7. become aware of ethical issues specific to human social interactions within the framework of a city
8. develop capacity for independent thought through self-selection of paper topics, service-learning experience, and selected readings

DOCUMENT 2

GS 102 Honors Seminar – City as Text – “Writing/righting the city” (public issue focus)
4 credits 4 - 0 - 4

Prerequisite: enrollment in the Honors Program

Students study the way a city functions and how people live and work together within a city. Students will research current issues in the city and select a topical area to study for the quarter. They will study raw data regarding what makes a city healthy (environmental data, safety data, etc.) related to the issues they have selected. Working in teams, they will organize public events/public hearings on selected issues, invite speakers, schedule the room, alert the media, etc. Students will write short reports related to their project topics and will write a formal proposal that a certain action be taken to solve a problem related to the selected issue.

Outcomes

Upon successful completion of this course, the student will be able to

1. write a variety of short reports, with an emphasis on conciseness, correctness, coherence, and contextual relevance
2. understand and apply principles of document design
3. develop appropriate visual representation of data

4. analyze raw data, identify significant data points and patterns among the data, and draw conclusions regarding what the data means
5. work with primary research sources in addition to secondary research sources
6. write a formal proposal, including all apparatus associated with formal reports
7. work as a member of a team to organize and manage an event
8. become aware of social issues and interact with members of the local community who are involved in the process of making public policy
9. make connections between professional training and social/civic contexts
10. develop capacity for independent thought through self-selection of the public policy issue and by proposing a solution to a problem related to that issue
11. create a succinct slide show with well-designed slides
12. deliver a team presentation

DOCUMENT 3

GS 103 Honors Seminar – City as Text – “Speaking the city” (aesthetics focus)

4 credits 4 - 0 - 4

Prerequisite: enrollment in the Honors Program

Students study architectural aesthetics and physical/temporal characteristics of the city. They will study art works, including music and theater, to discern patterns in the way cities are represented in art. They will study architecture and analyze the relationships between form and function. In addition, they may study public art, its role in city life, and the discourse surrounding it. Field trips to study the aesthetics of public spaces will be included. Throughout the quarter, students will create and deliver short presentations regarding their reading and research. At the quarter’s end a poster session event, planned by students and open to the public, will present student work discussing the relationships between a city’s ethos and its aesthetics. Students will also design presentation slides and posters that are both aesthetically appealing and rhetorically effective.

Outcomes

Upon successful completion of this course, the student will be able to

1. understand basic aesthetic principles, including relationships between form and function
2. become aware of social/civic issues surrounding the aesthetics of designing public spaces
3. develop awareness of audience in public speaking
4. prepare and deliver speeches and presentations
5. design effective slides and develop well-structured slide shows
6. work as part of a team to plan and stage a public speaking event
7. design an effective poster and speak to multiple audiences at a poster session event