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Sticky Innovation: Exploring the Problem of the Bees through Engineering and Art

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Dr. Gaskins joined the Engineering Education Department in 2014. She earned her Bachelor's Degree in Biomedical Engineering from the University of Cincinnati in 2008. Whitney earned her Masters of Business Administration in Quantitative Analysis from the University of Cincinnati, Lindner College of Business in 2010. She earned her Doctorate of Philosophy in Biomedical Engineering/Engineering Education also from the University of Cincinnati. Her dissertation "Changing the Learning Environment in the College of Engineering and Applied Science: The impact of Educational Training on Future Faculty and Student-Centered Pedagogy on Undergraduate Students" was the first of its kind at the university. Whitney has been recognized by the National Technical Association (NTA) for her novel approach to studying students, specifically underrepresented minorities and women.

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Nandita Baxi Sheth works at the intersections of Art, Education, and Community as Assistant Director Academic in the College of Design, Architecture, Art, and Planning at the University of Cincinnati. She works as DAAP's Liaison to the UC/Hughes Initiative to design, coordinate, and implement college access and summer bridge programming with UC's neighboring community high school. Additionally she serves as DAAP's Liaison for Diversity and Inclusion and leads the college wide Diversity and Inclusion Team. In 2015 she obtained a Masters in Visual Arts Education and Ohio State Licensure in Visual Arts Education. She teaches High School students in After School Programming with Hughes STEM HS and instructs in the Art Education Licensure progam. She has a background in Architecture and Planning with an B.A. from Rice University, majoring in Architectural Studies, English, and Art and a Master's of Community Planning from the School of Planning at DAAP. Her research interests include: the application of arts based research methodologies to consider "wicked problems"; the curricular impacts of art and technology on education; exploration and development of cross disciplinary STEAM initiatives, and using the lenses of affect theory and aesthetics to craft alternate forms of assessment.

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Introduction

STEAM is an initiative that proposes to incorporate arts and design with the sciences; STEM and Art = STEAM (Science, Technology, Engineering, Art & Mathematics) (Angier, 2010). In the twenty-first century the public debate about innovation has focused increasingly on the role of art and design disciplines as important sources of creativity and this term has been forged to designate a broadened definition of the foundational fields (Cantrell, 2015). Our paper describes an effort to transition from STEM education to STEAM education through an interdisciplinary collaboration between the College of Engineering and Applied Science (CEAS) and the College of Design, Architecture, Art, and Planning (DAAP) at the University of Cincinnati.

While creativity is most often associated with the arts, it is essential for innovative discoveries and applications in science and engineering (Costantino, Kellam, Cramond and Crowder , 2010). In this article, a pilot study is presented on how art inquiry and engineering design can be used together to solve a wicked problem. Simply put, wicked problems are slippery to define, difficult to resolve, and involve complex webs of stakeholders and issues (Camillus, 2008). In this pilot undergraduate honors course, students representing multiple disciplines collaborated to research, explore, and design solutions for bee colony collapse disorder. While humans are reliant on bees for pollinating essential food crops, the worldwide emergence of colony collapse disorder threatens the vitality of the honeybee population. The causes of colony collapse disorder are diverse and the solutions are yet to be defined. Students incorporated multiple approaches to inquiry to research this particular wicked problem of our time. Our course incorporated documentary film, fiction, arts based inquiry, research, and multiple modes of reflection to frame the design of creative solutions to complex problems. Engaging students in practices of attending to experience introduced them to artistic/creative reflective practices, design thinking, and aesthetic inquiry. Examining how artists interweave art, science, technology, and math in imaginative artworks that blur boundaries between art, design, and STEM disciplines developed "thinking dispositions that are valued both within and beyond the arts," (p. x, Hetland, Winner, Veenema, & Sheridan, 2013).

In this paper we discuss how an art educator and an engineering professor worked together to design and teach an undergraduate honors course to students from multiple disciplines at the University of Cincinnati. We discuss our planning process, share our course assignments, discuss challenges encountered, and reflect upon outcomes for our students. We explain how the course enhanced interdisciplinary collaboration, fostered deep discussion, and investigated the links that connect artistic and scientific disciplines. We believe that through intentional integration of engineering and art, students gained experience in a variety of modes of inquiry. They developed creative research approaches, problem solving skills, and innovative habits of the mind that will serve them in their respective disciplines well beyond the scope of the class.

Literature Review

Bridging the gap between art and engineering is not a new course of action, although the concept has been embraced by a variety of education advocates in more recent years. The initiative to add an "A" to STEM, to create STEAM, is burgeoning in engineering literature. The importance of collaboration between and across disciplines is noted in past and current literature on art and engineering. The benefits of collaboration have been distinguished in both engineering and art scholarly journals (Wynn & Harris, 2013; Arcadias & Corbet, 2015; Ochterski & Lupacchino-Gilson, 2016).

"Both science and art are valuable because they provide interesting and pleasing ways to see and be in the world" (Pugh & Girod, 2006). Collaboration between the two disciplines, allows for one to abandon their home disciplinary identity to expand and widen their range of knowledge (Sochacka, Guyotte, Walther, 2016). The scope of collaboration can be limited or as wide a scope as is appropriate for the situation. Simply making changes to an already established curriculum can reduce time and effort spent on collaboration (Ochterski & Lupacchino-Gilson, 2016). Collaboration is an inexpensive and effective way for cross-disciplinary courses to bring varying methods and ideas together. Finally, West (2016) proposes that teaching collaboration between disciplines is an essential direction for research universities in order to provide opportunities for students to: "...(1) to learn creative/design thinking, (2) to work on interdisciplinary teams, and (3) to have a safe opportunity to have authentic experiences where failure brings fewer consequences and where faculty can mentor and provide feedback," (p. 48). This expands the task of educators from imparting content knowledge to guiding students in experiences that produce new ideas (West, 2016).

Science education can improve if educators are focused on teaching for transformative, aesthetic experiences (Pugh & Girod, 2006). Within science education, the STEM community can benefit from creative collaborations with art and design by allowing engineering students to become more imaginative, innovative, and creative (Wynn & Harris, 2013). Collaboration with art and design is an advantageous way to integrate transformative teaching into science and engineering course-work. Wynn and Harris state that STEAM works because it can make mathematics less threatening, while still maintaining its rigor. In addition, they state that the greatest scientists are vivid visual thinkers. The collaboration exists by integrating inter-disciplinary concepts together. Through multiple methods and approaches, it is imperative that teachers allow students to make connections with art relating to their interests and expertise (Wynn & Harris, 2013).

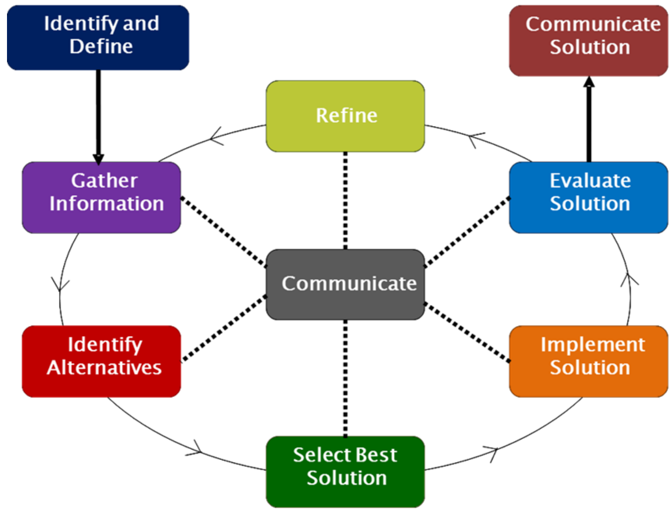
Art students will benefit from thinking in the perspective of scientists by becoming more systematic, critical, and conceptual thinkers (Wynn & Harris, 2013). A journal article by Corbet and Arcadias (2015), *Animating Fermi--A Collaboration Between Art Students and Astronomers* describes how art students were brought to NASA, which allowed them to think like scientists, giving them a better understanding of thinking critically and independently. Through class evaluations, and designed animations, the art students stated they were motivated to work independently, through a scientific lens, while incorporating their own approach. These prior collaborations laid the theoretical groundwork for developing our cross disciplinary course which we will proceed to describe in the next section.

Course Design

In this section we describe the genesis and design of our Honors course: *Sticky Innovation: Solving the Problem of the Bees through Engineering and Arts Based Research* offered as a cross disciplinary course in the Fall of 2016 at the University of Cincinnati, jointly listed as an Engineering Education Course in the College of Engineering and Applied Sciences (CEAS) and as an Art Education Course in the College of Design, Architecture, Art, and Planning (DAAP). Initially, working together on a summer bridge program for high school students, brought together an Engineering Professor (Gaskins) and an Arts Educator (Sheth). Through high school students' experience of researching the topic of the bees using multiple approaches to research, we realized the positive potentials of a trans disciplinary approach to problem solving. While this particular course chose to focus on the wicked problem of what is happening to the bees, we believe that the format of the course could be applied to any number of wicked problems (water, environment, poverty, etc.) to engage students in productive creative inquiry. The website developed for the course may be referenced for detailed documentation of learning experiences and articulations of projects: www.stickyinnovation.com.

The theoretical foundation of the course interweaves engineering design with art and design practices. First we describe the Engineering Design framework. The engineering design process (EDP) is the formulation of a plan to help an engineer build a product or solve a problem with a specified performance goal. This process involves a number of steps, and parts of the process may need to be repeated many times before production of a final product or solution can begin, please see **Figure 1** below. By learning to use the EDP students will be better able to approach a broad range of real-world challenges. In many cases, brainstorming solutions to an engineering design challenge requires creative thinking and both the ability and the confidence to think outside a prescribed set of parameters.

Figure 1: The EDP as adopted at the University of Cincinnati



In addition to an engineering design framework we consider industry based design thinking methods meshed with the academically based methods of arts based research. While the scope of this article prevents a lengthy divergence into these the arena of arts based research and design thinking, we briefly define them next. Class assignments were developed within a design thinking framework of human-centered design developed by the global design firm IDEO (Ideo, 2015). We developed assignments--Projects and Provocations (more on those later) keeping in mind IDEO's Mindset elements of Empathy, Iteration, Creative Confidence, Making, Embracing Ambiguity, and Learning from Failure. Course activities also incorporated design thinking concepts of Ideation and Implementation methods to evaluate research, define problems, establish audience/s, and develop solutions. In addition to design thinking methods, we were inspired by the methods of the emerging field of arts based research (Barone & Eisner, 2012). Arts based research often fits under the umbrella of qualitative research methods used in educational and social science research and proposes that diverse methods of representation (including both discursive and form based) are of value in raising questions, prompting conversations, capturing meaning, communicating to broad audiences, and ultimately contributing to a richer human understanding of complex experiences (Barone & Eisner, 2012). Some arts based research approaches used in our course include reading fiction, development of aesthetic skills, experiential learning, hands on making, and creative reflection.

From the theoretical frameworks informed by engineering design, design thinking, and arts based research, we developed course assignments which we describe as Provocations and Projects. Provocations were assignments designed to make students think about our particular wicked problem from multiple and shifting points of view. Projects were designed to engage students in attending to aesthetic experiences and introduce them to a variety of inquiry methods. Our Provocations included:

- Reading a novel which was narrated from the point of view of a fictional bee: *The Bees*, by Laline Paull.

- Watching documentary films about Colony Collapse Disorder and about philosophies of Making
- Watching Ted Talks on the topic of bees
- Visiting a functioning local beehive
- Visiting a local café with a mission to educate the public on the importance of bees to the ecology
- Reading an Engineering Design textbook and a selection of articles on innovation
- Guest lecture on aesthetics and art inquiry

A detailed Course Description and Calendar may be found in **Appendix 1**. The course met twice a week for one hour and twenty minutes. We designed the homework, projects, and presentations to address the following overarching themes:

- Weeks One and Two focused on *Defining the Problem* both through topical research and nonlinear concept mapping.
- Weeks Three and Four introduced students to *Arts Based Inquiry*.
- Week Five focused on concepts of *Craftsmanship*
- Week Six engaged students in *Drawing* exercises as a precursor to 3d modeling.
- In Weeks Seven through Eleven students were guided in *Lo-Fidelity Prototyping* and *3d Modeling* with Solidworks.
- During Weeks Twelve through Fifteen students ideated, developed, and presented a *Final Project*.

The course readings, viewings, and hands on experiences provided background for delving deeply into the research topic of the bees, specifically colony collapse disorder with the goal of ideating problem definitions and designing focused solutions.

We valued student participation and collaborative teamwork as an important element of the grade making up 20% of the total. Student teams were asked to develop "rules of engagement" for collaboration on their team project; thus setting expectations with each other for working together prior to the start of the Final Project. Students were also expected to present projects to the group. Projects were both individual (Aesthetics, Slow Art, Blog Post, Digital Portfolio) and team based (Ideal Bee, Final Project). A list of Projects is outlined in **Table 1** below.

Table 1. Projects

Projects	Learning Outcomes
Aesthetics Assignment: Choice of Everyday Aesthetics Exercise or Slow Art Exercise	Experience and document close observation using multiple senses and convey that experience with a creative response
Blog Post on Individual Research Topic to create a Collaborative Class Blog. Presented throughout class sessions as Buzz Presentations	Conduct individually defined research on the topic and share as a blog post on the class website including visual and text elements.

Lo-fidelity Prototype of the Ideal Bee	Identify and solve a problem (or cluster of problems) through redesign of the bee itself rapidly crafted with readily available materials.
3D Ideal Bee	Develop lo-fidelity prototype into a 3d model using Solidworks. 3d print the model using desktop 3d printing platforms.
Final Team Project	Define an aspect of the wicked problem to be solved and develop a creative, innovative solution. Develop an engaging presentation.
Digital Portfolio and Reflection	Document and create a Digital Portfolio of projects. Reflect on the learning experience of the class.

Our class was made up of 10 Honors students including chemical engineering, aerospace engineering, biomedical science, neuroscience, environmental engineering, music, ballet, and graphic design majors. Students ranged in experience from first semester freshmen to 5th semester seniors with industry work experience. Students selected the class for a variety of reasons ranging from a personal interest in the topic to a desire for project based learning. A breakdown of major, classification, and gender can be seen in **Table 2**.

Table 2. Major, Classification and Gender Breakdown for Honors Course

Table Glossary
CCM: College Conservatory of Music
DAAP: College of Design, Architecture, Art, and Planning
CEAS: College of Engineering and Applied Science
A&S: College of Arts and Sciences

Major				Classification				Gender	
CCM	DAAP	CEAS	A&S	FR	SO	JR	SR	M	F
2	2	4	2	3	0	4	3	4	6

Moving from our class design and context, we will next discuss learning outcomes for our students

Student Outcomes

Informal feedback from the students indicated that they rarely interacted with others outside their fields of study and that the course provided a unique experience to do so. Just as the students came together from different disciplines and considered the limitations and expectations of their respective disciplinary identities; the instructors (Gaskins and Sheth) explored the experience of teaching together from often perceived as vastly differing disciplines (Engineering and Art). As we worked together, we, like our students, began to realize that Engineering Design and Art Inquiry were connected in the areas of ideation, iteration, hands on making, and real life problem solving. These connections are aptly described in the final reflection on the class by graphic communication design freshman Audrey Eyman:

> This course opened my eyes about research and problem solving. I used to think of research and addressing problems like the bee crisis as something very scientific, a lot of reading research studies and coming up with chemical solutions. Research and problem solving do not have to be that way at all! This class helped me break the paradigm of how I saw research and showed me that research can be fun and creative and interesting. Real world experiences are a type of research. Watching a documentary is research. Looking at art and reading about artists is research. Reading a related fictional novel is research. Making a piece of art with a specific purpose is research. And this new view on research has opened me up to a new view on art and creativity's function in the world. The world's complex and wicked problems can be dealt with in many ways, and creativity should be at the forefront of how we consider them.
> Now more than ever I truly believe that interdisciplinary studies and cooperation between different fields of work are vital to the solution of our world's problems. In the future I hope to take part in more incorporative classes, work and collaborations. I hope that integrative learning like this class can continue to be a part of my time here at UC and cross-disciplinary collaboration can be something I push in my future. (http://audreyeymanuhp.weebly.com/sticky-innovation.html)

Throughout this course students were able to engage in multiple provocations and activities to enhance and expand their current thinking paradigm. Students reported an increase in scientific reasoning. They were challenged to follow the engineering design process while also learning to use engineering applications like Solidworks. Below is a final reflection by music student, Isaiah Postenrieder.

> This class opened my eyes to new ways of thinking. The engineering textbook pushed me to think more scientifically than I have in a long time. Exploring art as a method of inquiry was also an eye-opening experience and affirmed my conviction of the importance of art in modern society. Every exercise we did stretched my thinking further, especially the isometric and figure drawings. Working with SolidWorks was definitely the most frustrating part of my semester, but watching our bee 3D-print was so incredibly rewarding. I enjoyed working in two disciplines outside of my own, and with so many people with skill-sets so vastly different than my peers at CCM. My favorite part of this class was the fact that I am now equipped with knowledge to do something about a real-world problem. Moreover, I can share this knowledge with others in my life to make, even if small, a difference in the bee crisis.
> (http://isaiahpost.weebly.com/sticky-innovation.html)

Our students also reported an appreciation for multiple modes of inquiry. At the beginning of the semester the students indicated they were unaware of art as a mode of inquiry but after taking this course students were able to better understand the link between engineering and artistic thinking. A reflection on the cross-disciplinary approach is made by industrial design student, Adam Pozdro.

> I have also begun to understand an interdisciplinary approach to problem solving. Through this class I have worked in my comfort zone with other designers and artists as well as those on other tracks such as engineering and organic sciences. I understand that this approach allows for expansion of thought as well as expertise that can be used to broaden designs and products into more realms. They also allow more learning for me, for I have always been interested in science and engineering. I have been inspired to seek out this kind of interdisciplinary grouping with my own personal, as well as assigned, work. (http://adampozdro.weebly.com/sticky-innovations.html)

Finally, our students noted that participating in this course empowered them to feel they could address some of the most challenging problems the world faces today. Students gained leadership and teamwork skills through collaboratively addressing a real life “wicked” problem. We fostered that sense of agency through a deliberate focus on innovation and creativity rather than immediately achievable or realistic outcomes. For example, the redesign of the bee was not limited by the constraints of current biological developments. Students were encouraged to think in terms of possibilities rather than constraints. While developing agency was not an initial learning outcome for our class we believe now that skill development, collaboration, and real life problem solving is an important experience for students to have within the context of the university. In the next section we explore the tangible results of these approaches as we discuss students’ Final Projects.

Design and Prototyping

Students were able to engage in different modes of inquiry to develop innovative solutions to the wicked problem they had been steeped in throughout the semester. As part of the final project students were split into three teams to learn to work collaboratively, across disciplines, and apply individual perspectives, experience, and skills to both define a particular facet of the wicked problem and create a new solution and/or concept beyond the scope of any one individual. Each team defined the problem in a different way and developed a unique solution. Team One, SmartHive, developed a new type of beehive to make beekeeping accessible to everyone. Their goal was to invigorate the market of beekeeping. Most beekeepers keep their bees for profit and are in the business of raising them. If they could expand the keeping of bees to become more recreational they could both increase the number of bees and gain visibility and empathy for bees and the problems of colony collapse disorder. The hive they developed came with many different built in solutions in order to ease the process of hive setup. In addition, they included hive maintenance by combining existing technologies and soon to be patented technologies. Supplementing the hive itself, they included modular technologies such as garden boxes, which would provide sustenance for bees in the nearby area and begin the process of reintroducing native plants back into Cincinnati. Team One is currently working with a development team to patent their innovative beehive design.

Team Two, Low-Effort Activism, developed a non-profit outreach organization whose aim was to create a culture of bee friendly attitudes and practices through outreach and other community engagement activities. The organization, named Sticky Innovation, was designed to work with schools through educational events, as well as city governments by providing easily implementable, bee-friendly tasks. Sticky Innovation was also designed to provide interested parties with resources to keep their own apiary and/or create a bee-garden.

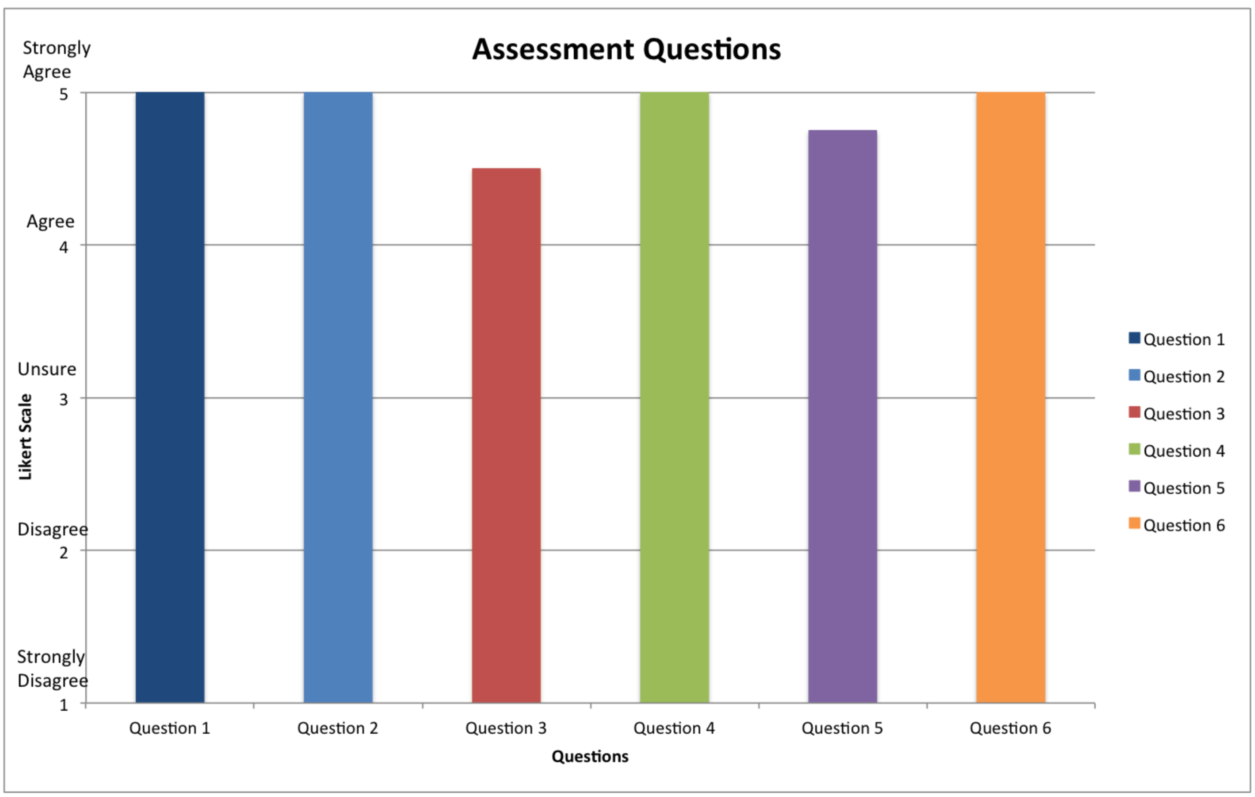
Team Three, Colony Collapse Interactive App, proposed an interactive game application that allowed players to experience the different causes of colony collapse and how these causes may collectively create a wicked problem that requires various solutions. The game was designed to be fun but was also geared towards planting the seeds of awareness. Interestingly, the students, of their own accord,
decided to align a synergy between the Three Final Projects so that they would complement each other and create an ecosystem to support the bees. The Final Projects may be reviewed on the class website.

At the end of the semester students were asked to evaluate the course. The survey given was not part of the course grade and was voluntary. The survey was coordinated through the University Honors program and consisted of the following 6 questions:

1. The course content was engaging
2. The course content is of value to me
3. The course content was challenging
4. The instructor is an excellent teacher
5. The instructor communicated clear expectations for the course
6. I would recommend this course to other students

Out of the 10 students enrolled, 4 completed the survey. Scores on the survey were based on a 5 point Likert scale ranging from strongly agree to strongly disagree. The average score for each construct was 4.875. Students indicated "strongly agree" for three questions; the course was engaging, valuable, and would recommend to others. A summary of the scores can be found below in **Figure 2**.

Figure 2: Results from the end of the Course Assessment



While we had admittedly low response from the Honors survey; our final class discussion and students' reflections on the class found in their portfolios provide additional data fields that support a successful achievement of learning outcomes overall.

Professor Outcomes and Recommendations

We found that changing students' thinking paradigms is very challenging. Students feel discomfort when asked to go outside of conventional norms such as lectures, tests, rubrics, and quantitative grading methods of their respective disciplines. Many of the provocations and projects assigned were deliberately open ended--not simply to encourage artistic creative self expression but to provide opportunity for expansive creative critical ideas to develop. We maintained rigorous expectations for students while demanding the out of the box thinking that innovations require. Developing comfort with discomfort, working collaboratively with people from other disciplines, and attaining agency through their individual talents and skills were all arenas where we saw significant student growth, particularly articulated in the Final Project presentations. Students also expressed gratification at the opportunity to work across disciplines, learn from each other, and even share strengths with each other. For many it was the only class that held space for that experience in their University career. While time consuming to plan, the rewards for students and faculty are worthwhile, therefore, we recommend that others take on initiatives to create interdisciplinary courses within the university context.

While we initially imagined that integrating engineering with art would be a challenge, we (the instructors) quickly made the connections between engineering and creative thinking processes. We found the most challenging aspect of the class to be the time constraints presented by teams working together from different disciplines with vastly ranging schedules. We addressed this concern by providing in class workshop times and by asking the students to develop team rules of engagement. We were fortunate to have a dedicated classroom reserved for the class, DAAP's Art Inquiry Lab. In that space we could leave work in progress on the walls and work tables, iterate with 3d printers, and easily access a variety of art making supplies. Another struggle was finding the balance between content delivery and skill acquisition. For example several students expressed a desire to learn more about the biology of bees while others asked for more time to work on 3d Modeling and Printing. Despite the difficulties presented by course time frames, we recommend instructors continue to seek a balance between content, research, skill development, and implementation and respond sensitively to the student and spatial context of the class.

MIT Media Lab's Neri Oxman (2016) proposes that we are in an "Age of Entanglement" where the boundaries of Art, Science, Design, and Engineering intersect and contemporary problems often appear at the intersections or in between spaces of the disciplines. If we accept this concept, it is imperative that we create sites within University structures that support and allow teaching and learning to flourish between and around the traditional disciplines. In our class, *Sticky Innovation*, we set the conditions to prepare our students (through practice) to "occupy all four domains simultaneously," (Oxman). Like honey, we hope the methods of inquiry practiced by our students will continue to remain a little sticky; staying with them as they move forward into a variety of careers and problem solving scenarios of the future. Finally, we also hope that our experiences inspire and provide direction for others to design and teach across disciplines to address real life wicked problems.

APPENDIX ONE: Course Description and Calendar

Course Description

Course Overview

While humans are reliant on bees for pollinating essential food crops the worldwide emergence of colony collapse disorder threatens the vitality of the honeybee population. In this course students will learn multiple approaches to inquiry to consider this “wicked problem” of contemporary times. This course incorporates documentary film, fiction, arts based inquiry, scientific research, and multiple modes of reflection to design creative solutions to the problem with the bees. The course will seek to enhance interdisciplinary collaboration, foster discussion and investigate the links that connect artistic and scientific disciplines. Integrating engineering and art, students will gain experience in a variety of modes of inquiry that will develop creative research approaches, problem solving skills and innovative habits of the mind.

Following Massachusetts Institute of Technology (MIT) Center for Art Science and Technology (CAST) mission this course, “creates new opportunities for art, science and technology to thrive as interrelated, mutually informing modes of exploration, knowledge and discovery” (http://arts.mit.edu/welcome/cast/about/#curricula) that align with both the University of Cincinnati’s mission and the Honor’s program mission to offer students creative sites of potentially transformative cross disciplinary experiential learning.

Learning Objectives: Students will

- Practice arts and science based approaches to inquiry, expression and presentation
- Present research findings in non-traditional ways (beyond PowerPoint and posters)
- Develop a toolbox of rhizomatic aesthetic and observation skills in order to analyze complex biological and scientific problems creatively
- Incorporate a variety of points of view and contexts in the design of innovative solutions through empathetic understanding of complex problems
- Develop cross-disciplinary collaborative team working skills

Course Calendar | Fall 2016: T and Th 2:00-3:20pm

Date	Homework/Prep	In Class Activities	Blog Post Roster	Projects Due
Week 1: Why Bees?				
T	First Day of Class	Introductions Review Course Syllabus,	Sign up for Weekly Blog Posts	

		Watch Ted Talk Maria Spivak	Provide links to your Digital Portfolio	
Th	Watch: Anand Varma Ted Talk Read: Engineering Design Ch. 1 *The Bees*, pgs 1-41	Watch documentary in class : Queen of the Sun		
Week 2: Defining the Problem				
T	Read: *Strategy as a Wicked Problem*, Harvard Business Review Engineering Design, Ch 3	Discussion of Documentary and Readings Mind Mapping Activity		
Th	Read:*The Bees,* pgs 43-95 Prepare 3 questions for Field Trip	Visit Greenacres Foundation Beehive Field Trip		
Week 3 and 4: Arts Based Inquiry and Aesthetics				
T	Read: Alva Noë, *What Art Unveils* Alva Noë, Making Art from Life Watch: Richard Feynman Ode to a Flower Look: Revolt They Said, Andrea Geyer	Guest Lecture:Dr. Kristopher Holland: Arts Based Research, Aesthetics,and Poïesis Followed by discussion		
Th	Read: *On Looking*, pgs 185-259 *Seeing is forgetting the name of the thing you see*, pgs. 207-215	Honey tasting activity Discussion of Readings	Start Buzz presentations	
T	Read: *the Bees*, pgs 97-124	Share responses/critique format- Introduce Critique		Due in class: Everyday Aesthetics Response
Th	Watch: Power of Outrospection		Buzz presentations	
Week 5: Engineering Design and Craftsmanship				
T	Read *The Bees*,	Watch: "Being in the World"		

	pgs.125-148 Chapter 8 Engineering Design			
Th	Read *The Bees, pgs.* 149-199	Discuss Movie and Present Artifacts	Buzz Presentations	Bring a material cultural artifact that exemplifies good craftsmanship to you and be ready to present why.
Week 6: Drawing				
T Sept 27	Read Chapter 9 Engineering Design	In Class Drawing exercises Engineering drawing Contour, Blind Contour drawing		
Th	Read Chapter 10 Engineering Design *The Bees*, pgs. 201-244		Buzz Presentations	
Week 7: Lo Fidelity Protoyping the Ideal Bee				
T	https://www.smashingmagazine.com/2014/10/the-skeptics-guide-to-low-fidelity-prototyping/	Make (lo-fidelity) prototype Play with 3d Doodler Pen, Sense Scanner, 3d Printers Divide into Groups for different bee parts		
Th		Present Prototypes Ideate final project: what will solve? What question will you answer? What will you make?	Buzz Presentations	
Week 8: Final Project Planning				
T	Lunch at Sleepy Bee Cafe, 3098 Madison Rd, Cincinnati, OH 45209	Meet 1: 30 for Bus Discuss Final Project Planning		
Th	Reading Day- no class			
Week 9, 10, 11: Smartworks and 3d Modeling the Ideal				

T Oct 18	Read: the Bees, pgs. 245-278	Demos, Modeling, Work in Class		
Th Oct 20		Workshop in class		
T Oct 25	Read: *The Bees*, pgs 279-338	Workshop in class		
Th		3d Printing Introduction		
T Nov 1		3d Printing		
Th Nov 3		Present Ideal Bee		Print Ideal bee, scan and print individual models for class
Week 12: Documentation and Presentation				
T Nov 8	Read: Edward Tufte excerpts Watch: Dance vs. Powerpoint	Workshop Final Presentations		
Th		Workshop Final Project		
Week 13: Workshop				
T		Workshop Final Project		
Th		Workshop Final Project		
Weeks 14, 15: Final Project and Presentations				
T		Workshop Final Project		
Th	Thanksgiving Break			
T	Final Project Presentations	with guest critics		
Th				Digital Portfolios due

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