A GUIDE TO DEVELOPING, DELIVERING, AND ASSESSING AN INTERDISCIPLINARY CAPSTONE COURSE FOR TWO-YEAR BUILT ENVIRONMENT PROGRAMS BASED ON THE BEST PRACTICES OF THE BUILT ENVIRONMENT DEPARTMENT AT SINCLAIR COMMUNITY COLLEGE

by
Eric C. Dunn

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Eric C. Dunn

Has been approved

March 2021

APPROVED:

Jared Cutler, PhD_____
Committee Chair

Tina Hummons, EdD_____
Committee Member

Dawayne Kirkman, PhD_____
Committee Member

Dissertation Committee

ACCEPTED:

Sandra J Balkema, PhD, Dissertation Director____
Community College Leadership Program

ABSTRACT

This product dissertation is a “how to” manual for departments or faculty wishing to simulate the real-world experience of working across disciplines through development and implementation of an interdisciplinary capstone course. It is based on the best practices, procedures, struggles, and successes of Sinclair Community College’s Built Environment Department. While the guide primarily focuses on the programs of Architectural Technology, Civil Engineering Technology, and Construction Management Technology, it can be used as a framework for developing an interdisciplinary course for other programs at both two-year and four-year institutions. The guide is presented in three main sections. The first is the preliminary steps necessary to develop and plan the course. These topics focus on the work of faculty that should take place well before the term begins. The second section focuses on the delivery of the capstone and revolves around the project solutions developed by the interdisciplinary student teams. The final section describes effectively assessing an interdisciplinary capstone including the evaluation of individual students, student teams, and disciplines.

KEY WORDS: Built environment, interdisciplinary, capstone, assessment, service learning

DEDICATION

I dedicate this work to my children: Nathan, Kaitlin, Andrew, Wayne, Stephen, and Henry. I hope your lives are continually filled with curiosity and passion for the amazing world around you…may you continually keep learning and growing!

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First and foremost, I wish to acknowledge the unwavering support and encouragement of my wife and best friend, Cherilyn. She is the love of my life and has been a tremendous blessing to me during this doctoral journey as a sounding board for ideas, feedback, and perspective. THANK YOU, sweetheart!

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CHAPTER 1: INTRODUCTION

INTRODUCTION

Much of the success of community colleges in the United States is the direct alignment they have with current industry trends and needs. From healthcare to advanced manufacturing, community colleges focus on offering the certificates, associate degrees, and skillset training that allows individuals to secure employment or enhance their earnings in in-demand fields. Because the needs of employers typically change from region to region, community colleges offer a unique opportunity to educate students with customized curriculum.

Ensuring that curriculum is based on the needs of regional employers is key to the employability of students. While balancing state credential requirements with institutional and accreditation requirements, the content of this curriculum is often guided by advisory board members made up of local business and government interests, craft professionals, and college alumni. In addition, professional organizations, either represented on campus as a local chapter or through faculty membership, can provide a bridge between the school and industry employers by offering seminars, continuing education workshops, and training.

These industry professionals and associated organizations are key in helping programs stay current with trends, resource needs, and credentialing. It is in this context that the interdisciplinary project delivery capstone was developed at Sinclair Community College during the 2008-09 academic year.

THE CAPSTONE CONCEPT

While many programs have an end of program course to evaluate student learning and mastery of key concepts and principles, a project-based capstone is most commonly found within bachelor's or master's degrees and is sometimes referred to as a senior thesis. Many associate degree programs do not have a capstone course, and those that do are typically limited in scope. Few offer an interdisciplinary course where students from several disciplines work together. Even bachelor's and master's degree programs do not frequently use the multiple discipline approach.

PURPOSE OF THIS PRODUCT

This product dissertation is a "how to" manual for institutions and departments wishing to develop and run an interdisciplinary capstone course. It is based on the best practices, procedures, challenges, and successes of Sinclair Community College's Built Environment Department's capstone course. Their unique approach regularly combines students in the disciplines of Architectural Technology, Civil Engineering Technology, Construction Management Technology, and Energy Management Technology to answer a design challenge. Many times, it has expanded to include other departments within the college such as Aviation Technology, Culinary Arts, and Interior Design. It has also included students from a neighboring private four-year university.

Many of the projects, selected by faculty, either closely mimic real-world design challenges or require the students to work with actual community or business interests to develop a set of deliverables that usually include architectural plans (blueprints), construction cost estimates, project schedules, civil site plans, and energy efficiency studies. When working with clients from within the community, these projects are classified as service learning.

SCOPE

While there have been various combinations of disciplines that have participated in Sinclair's interdisciplinary capstone being spotlighted in this dissertation, this document will focus primarily on the information gathered by combining of three of the department's core programs: Architectural Technology, Civil Engineering Technology, and Construction Management Technology. These programs have been a part of this unique capstone approach since its inception in spring of 2009 and have been included every year since.

BACKGROUND AND EVOLUTION

Prior to the integrated approach currently used by the Built Environment Department, capstone courses were conducted as an individual class with standalone projects by a single discipline. Students worked on projects developed by faculty, independent of help or input from another program. Previous projects delivered in this format include a health care facility designed by architectural technology students and the design of a park by Civil Engineering Technology students (Sinclair Community College, 2003). Course design, project requirements, grading, and policies were developed by their respective faculty independent of one another.

In 2008, Larraine Kapka, then chair of the Engineering Technology Design Department (which later was split into two separate departments: Mechanical Engineering Technology/ HVAC and Built Environment) participated in an ASHRAE (American Society of Heating, Refrigeration and Air-Conditioning Engineers) conference where the focus was optimizing projects using BIM (Building Information Management). This optimizing approach harnesses the backend data of building systems, materials, construction, and commissioning to help reduce design conflicts and increase efficiencies in construction and operation. This process results in lower overall construction and operating costs. At its core, the process heavily relies on

professionals from multiple disciplines working together to develop optimal solutions well in advance of the start of actual construction.

While discussing this concept with fellow HVAC-R (Heating, Ventilation, Air Conditioning, and Refrigeration) faculty member, Russell Marcks, Professor Kapka proposed incorporating this concept into Sinclair coursework to help prepare students for this evolving industry trend. Later that academic year, Professor Kapka submitted a proposal to the college to bring one of those webinar presenters, Walter Grondzick, to Sinclair to present this integrated approach. Mr. Grondzick is a professor of architecture at Ball State University in Muncie, Indiana, and had been a presenter at the ASHRAE conference. While at Sinclair, he spoke to engineering technology faculty, students, and the local chapter of ASHRAE. The value of this approach soon became apparent, as it included components that helped prepare students for work in industry, including running team meetings, record keeping, and working with advisory board members.

After several months of development, the first integrated capstone started in spring quarter (the college has since moved to semesters) of 2009. The project was a new academic building on Sinclair's Dayton campus and used Autodesk Revit, a 3D architectural design tool, as its collaborative technology. Advisory board members were included to help guide students through the project and help give professional advice on balancing customer requirements with a creative design approach. It was purposely designed to put students outside of their comfort zone and expose them to challenges in which they had little to no exposure up to that point in their studies.

BUILDING INFORMATION MODELING

Building Information Modeling has various definitions, but is generally defined as "giving architects, engineers, and construction (AEC) professionals the insight and tools to more efficiently plan, design, construct, and manage buildings and infrastructure" (Autodesk, 2016). This collaborative approach is polar opposite of the linear methods where the architects design the building, then the structural engineers design the load bearing supports, and then the mechanicals design the building systems.

Some Sinclair faculty initially pushed back and wanted to revert to the old way of teaching capstone: working in silos with no collaboration among disciplines. However, the collaborative approach quickly became the preferred method to teach the capstone courses.

EXPANSION

Throughout the years, faculty have worked to incorporate other departments from within the institution into the design challenge. This has included the departments of Interior Design, Culinary Arts, and Aviation Technology, each of which played varying roles during the term.

The interior design department has participated more regularly than any other department. These students are selected by Interior Design Department faculty. In addition, a faculty member from the department is assigned to help be a consultant for the group and provided a bridge between Interior Design students who may have only had one class in the Built Environment Department to students in the architecture, civil, and construction programs.

Culinary Arts students have been utilized as consultants in helping built environment students design restaurants and commercial kitchens. Layout, safety, food storage, and preservation requirements were all important aspects of their participation in helping built environment teams understand the needs of the client.

Likewise, Aviation Technology students acted as consultants during a design challenge where Built Environment students were tasked with designing an airplane hangar and associated airport service buildings.

UNIVERSITY COLLABORATION

In 2014, Sinclair faculty began working with their faculty counterparts at the University of Dayton, located just a few miles away, to develop an integrated capstone between the two institutions. This partnership would combine Sinclair capstone students in Built Environment programs with capstone students in UD's Civil Engineering program. The primary focus of this partnership, which would launch in spring of 2015, was to offer students at both schools access to additional disciplines of study. The University of Dayton does not have an architectural program and Sinclair's Civil Engineering Technology program is heavily focused on surveying. The University of Dayton Civil Engineering program includes concentrations in structural, geotechnical, and transportation. By combining students, Sinclair students were exposed to an additional layer of integration and collaboration, not just in discipline, but also in communication and scheduling.

This partnership continues, with projects over the years ranging from a large conference center to the redevelopment of the vacated Montgomery County Fairgrounds into a mixed-use neighborhood featuring residences over commercial properties. The Sinclair students are typically in their last semester of study with sophomore status and the University of Dayton students are in their last semester as seniors.

CONTINUOUS IMPROVEMENT

The interdisciplinary capstone has evolved over the past decade, with faculty standardizing processes like grading and midterm review sessions. The faculty have also worked to ensure that the projects themselves are fresh, robust, timely, and challenging. In ten years, only a couple of projects have been repeated. Those projects include a health sciences building on Sinclair's campus and a simulated large-scale wastewater treatment facility. When possible, changes to variables such as land parcels or project scope are made to help challenge students and keep the project interesting for faculty.

The faculty have also worked to standardize processes, grading rubrics, presentation formats, the semester schedule, and advisory board involvement. Much of their work comes from trial and error and is the basis of Chapter 4 of this dissertation.

STUDENT EVALUATIONS

Advisory board participation has been instrumental in providing feedback to teams. Select advisory board members are asked to evaluate student progress during a midterm presentation about halfway through the course. This is an intimate setting where industry professionals have the opportunity to give direction, provide constructive feedback, share real-world experiences, make suggestions, and answer questions.

At the end of the term, the department hosts a capstone dinner and expo for all capstone students, department faculty, school administrators, advisory board members, and selected guests. The expo does not require a formal presentation from students, but rather allows them to interact with invitees on a one-on-one basis in a tradeshow format. Invitees evaluate students through an electronic survey form taken with their smartphones. This form is delivered and

compiled by Sinclair's Research and Analytic Reporting (RAR) office with questions derived from program and course outcomes.

COURSE DESCRIPTION AND OUTCOMES

One challenge of the interdisciplinary approach is that the capstone course must meet the outcomes for each unique program involved. For Sinclair's Built Environment programs of Architectural Technology, Civil Engineering Technology, and Construction Management Technology the course descriptions are similar, but the outcomes are slightly different. In accredited programs, such as those accredited by ETAC/ABET, specific program outcomes will be dictated by the professional organization for that discipline. All three core programs (Architectural Technology, Civil Engineering Technology, and Construction Management Technology) at Sinclair are currently ETAC/ABET accredited. The description for each discipline follows:

> Architectural Technology
>
> CAT2780 Architectural Technology Capstone, 4 Credit Hours. Assessment of achievement by Architectural Technology students in attaining program outcomes by completing a project demonstrating principles and practice of the major. Teamwork on projects will be emphasized. Only offered spring semester. Should be taken last spring term of program. Two classroom, six lab hours per week. Prerequisites: Approval of Department (Sinclair Community College, 2018a)
>
> Civil Engineering Technology
>
> CAT2781 Civil Engineering Technology Capstone, 4 Credit Hours. Assessment of achievement by Civil Engineering Technology students in attaining program outcomes by completing a project demonstrating principles and practices of the major. Teamwork on projects will be emphasized. Only offered spring semester. Should be taken last spring term of program. Two classroom, six lab hours per week. Prerequisites: Approval of Department (Sinclair Community College, 2018b.)
>
> Construction Management Technology

> CAT2782 Construction Management Technology Capstone, 4 Credit Hours. Assessment of achievement by Construction Management Technology students in attaining program outcomes by completing a project demonstrating principles and practice of the major. Teamwork on projects will be emphasized. Only offered spring semester. Should be taken last spring term of program. Two classroom, six lab hours per week. Prerequisites: Approval of Department (Sinclair Community College, 2018c).

PROGRAM OUTCOMES

Program outcomes for each discipline in the interdisciplinary capstone are unique to the craft and skillsets students learn while pursuing their respective degree. In ETAC/ABET programs, there are two sets of outcomes, one general set that focuses on basic outcomes related to an associate degree in technology and one set specific to the discipline. These later outcomes are developed by the affiliate societies of the discipline and include program specific skillsets that vary from program to program.

Recently, ABET revamped the technology degree outcomes to make them more succinct and recommends that programs adopt them as stated to make the accreditation review process easier. In 2019, at the Built Environment Department's advisory board meeting, members voted to adopt the general associate degree outcomes and the proposed discipline specific outcomes as written by ABET. They are:

1. an ability to apply knowledge, techniques, skills and modern tools of mathematics, science, engineering, and technology to solve well-defined engineering problems appropriate to the discipline
2. an ability to design solutions for well-defined technical problems and assist with the engineering design of systems, components, or processes appropriate to the discipline
3. an ability to apply written, oral, and graphical communication in well-defined technical and non-technical environments; and an ability to identify and use appropriate technical literature
4. an ability to conduct standard tests, measurements, and experiments and to analyze and interpret the results
5. an ability to function effectively as a member of a technical team (ABET, n.d.).

In addition, program specific outcomes for **Architectural Technology** are:

a) employ concepts of architectural theory and design in a design environment

b) utilize instruments, methods, software, and techniques that are appropriate to produce A/E documents and presentations

c) utilize measuring methods that are appropriate for field, office, or laboratory

d) pply fundamental computational methods and elementary analytical techniques in sub-disciplines related to architectural engineering (ABET, n.d.).

Program specific outcomes for **Civil Engineering Technology** are:

a) utilization of principles, hardware, and software that are appropriate to produce drawings, reports, quantity estimates, and other documents related to civil engineering

b) performance of standardized field and laboratory tests related to civil engineering

c) utilization of surveying methods appropriate for land measurement and/or construction layout

d) application of fundamental computational methods and elementary analytical techniques in sub-disciplines related to civil engineering (ABET, n.d.).

Program specific outcomes for **Construction Management Technology** are:

a) utilization of techniques that are appropriate to administer and evaluate construction contracts, documents, and codes

b) estimation of costs, estimation of quantities, and evaluation of materials for construction projects

c) utilization of measuring methods, hardware, and software that are appropriate for field, laboratory, and office processes related to construction

d) application of fundamental computational methods and elementary analytical techniques in sub-disciplines related to construction engineering (ABET, n.d.).

ACCREDITATION ASSESSMENT

The integrated capstone has also been successful in helping gather accreditation data and student artifacts. In addition to specific courses within the respective built environment disciplines, the faculty have mapped all outcomes listed in the previous two sections of this

chapter to the capstone course. The faculty feel that students demonstrate each of these outcomes at some point during the course and, when combined with data gathered from the other courses within the program, create a strong presentation to show evaluators the kind of success Sinclair is having in educating students in these programs. Sinclair Community College, as an institution, is accredited by the Higher Learning Commission.

ABBREVIATIONS, DEFINITIONS, AND TERMINOLOGY

Throughout this document, the following terms will be used regularly. To avoid confusion about their use and meaning, these definitions are provided here.

ABET	Accreditation Board for Engineering and Technology. A not-for-profit organization that accredits educational programs for both two-year colleges and four-year universities.
Accreditation	A set of recognized standards set by an accrediting agency used to evaluate the quality and rigor of a program.
Advisory Board	A group of industry representatives that help guide curriculum development and delivery by recognizing current and future industry needs and emerging trends.
Annual Update	A brief update of a program at Sinclair Community College. Information reported to the college and its stakeholders includes enrollment trends and progress towards program goals.
Artifacts	Student work collected for assessment.
ASHRAE	American Society of Heating, Refrigeration, and Air-conditioning engineers.
Assessment	The evaluation of a program through review of curriculum, coursework, and student artifacts.
BIM	Building Information Modeling
Built Environment	A term used to describe the physical built world that includes roads, bridges, buildings, and infrastructure.

Capstone	A course normally taught during the last term of a student's program that requires them to draw upon their previous coursework to develop a solution to a real world or similarly designed challenge.
eLearn	The online course management system used by Sinclair Community College. This platform is a branded Desire2Learn / D2L product.
ETAC	The Engineering Technology Accreditation Commission of ABET that accredits technology programs.
ETD	Engineering Technology Design Department. A former department within the Science, Mathematics, and Engineering Division at Sinclair Community College that housed built environment disciplines.
Exit Interview	Interviews conducted by the department chair of all capstone students in their last semester to gain a better understanding of the student's experience while in their program of study.
HLC	Higher Learning Commission. A regional accreditor for post-secondary institutions that accredits Sinclair Community College.
HVAC-R	Heating, Ventilation, Air Conditioning, and Refrigeration
IRB	Institutional Review Board
Interdisciplinary	The combining of students from multiple programs who work together to solve a design challenge.
Lessons Learned	The documenting of both achievements and failures in order to find themes, best practices, or bottlenecks in order to fix issues or continue what works well.
Program Review	An in-depth review of a degree program at Sinclair Community College. This review happens every five years and is comprised of various committee members including the Provost, Dean, Chair, Faculty, and select support service leaders.
RAR	Research, Analytics, and Reporting. A department at Sinclair that handles all institutional data for the college.
Rubric	A document that guides the evaluation of students by using pre-established grading criteria.
Service Learning	Coursework that provides a good or service to the community, often with little or no monetary cost to those it benefits. Students gain experience working with the community while engaging in course assignments or projects.

SCC	Sinclair Community College. An open enrollment college founded in 1887 with nearly 30,000 students. Located in Dayton, Ohio, the institution awards over 8,000 credentials from over 220 associate degree and certificate programs.
SME	Science, Mathematics, and Engineering. One of the four academic divisions at Sinclair Community College.
STEM	Science, Technology, Engineering, and Mathematics
UD	University of Dayton. A private catholic university in Dayton, Ohio with approximately 12,000 students.

CHAPTER SUMMARY

The interdisciplinary capstone course within the Built Environment Department at Sinclair Community College is a unique approach in teaching industry collaboration principles as well as assessing student outcomes. This course structure allows faculty to develop projects that are more challenging to students and require constantly collaborating as a team in order to be successful.

The focus of this product dissertation is an integrated capstone “how to” manual based on the best practices of Sinclair’s interdisciplinary capstone course within the Built Environment Department. It is intended to be a guide for departments and programs that wish to incorporate this approach at either the two-year or four-year level.

CHAPTER 2: LITERATURE REVIEW

INTRODUCTION

This literature review helps support key aspects of a successful interdisciplinary capstone program. The references and literature presented in this chapter are specific to interdisciplinary coursework, capstones, and their related components and assessment. In addition, the information helps support best practices and offers users of the "how to" guide found within Chapter 4 additional considerations when developing, delivering, and assessing such a program.

The research presented encompasses work from scholars and educators within the built environment, engineering, and related STEM programs from both colleges and universities and includes findings based on research and analysis of integrated programs by a wide range of authors.

TERMINOLOGY

There is no single definition that defines interdisciplinary coursework. Unfortunately, "a complex lexicon has arisen in trying to describe the nature of those interactions focused on a common endeavor, using the prefixes cross-, multi-, trans-, or inter- in combination with the word 'disciplinary'" (Quinlan, Corkery, Zamberlan, Ward, 2010, p. 1). For example, Davies and Devlin (2007) identify a spectrum of cooperation when working across teams including using the terms relational interdisciplinarity, exchange interdisciplinarity, pluri-disciplinarity, modification interdisciplinarity, and trans-disciplinarity. According to the Council of Independent Colleges, interdisciplinary courses are most common at independent universities and colleges, though there does not seem to be a widely accepted definition (Katz, 2015).

For clarity of this dissertation, the following definition of interdisciplinary, as defined by the U.S. Center for Educational Research and Innovation, will be used:

> An adjective describing the interaction among two more different disciplines. This interaction may range from simple communication of ideas to the mutual integration of organized concepts, methodology, procedures, epistemology, terminology, data and organization of research and education in a fairly large field. An interdisciplinary group consists of people trained in different fields of knowledge (disciplines) organized into a common effort on a common problem with continuous intercommunication among the participants from the different disciplines. (Lattuca, 2002, p. 712)

The overarching goal of interdisciplinary study is, as Palmer (2001) notes, to solve complex problems that "rarely arise within orderly disciplinary categories, and neither do their solutions" (p. vii). This is further supported by Bridle, Vrieling, Carillo, Araya, and Hinojosa (2013) who state that interdisciplinary education is the integration of knowledge from multiple disciplines to address issues that cannot be solved by only one discipline.

Interdisciplinary education also allows students to see the interdependencies among disciplines (Ashby & Exter, 2018). Interdisciplinary education allows students to develop ways of thinking that "produce a cognitive advancement" that would not have been likely through only a single discipline (Biox-Mansilla & Duraising, 2007, p. 219).

Regardless of the term used to describe the process, communication, as stated by Lattuca (2002), is key part of interdisciplinary work. Corkery (2007) expands this definition by stating communication must take place between the instructors, the team, and the students within the team and that the learning experience itself is just as interdisciplinary as the activity.

INTERDISCIPLINARY COURSE THEORY

Perhaps the most compelling reason for interdisciplinary education is the fact that the world is becoming more interconnected and complex (Katz, 2015). A well-designed course will mimic the real-world environment that students will experience upon entering the workforce in

their chosen field of study. Quinlan, Corkery, Zamberlan, and Ward (2010) state that both built environment professionals and educators want students who engage in interdisciplinary learning so they will be able to contribute as leaders in their professions. Collaborative education can also lead to more powerful, holistic, dynamic experiences for student (Haynes & Leanord, 2010). In addition, interdisciplinary education helps students "locate, retrieve, understand, and use information" (Davis, 1995, p. 38).

The theories and approaches of a single discipline in education have evolved into interdisciplinary offerings that involve different perspectives and fields (Yang, 2013). In 2013, Hill suggested that interdisciplinary education makes sense because it promotes greater engagement in learning, fosters creative thinking, enhances cognitive skills, and helps students become sensitive to ethical issues. Challenges that exist both locally and globally cannot be adequately addressed by any single discipline and that the goal is to integrate interdisciplinary experiences that reflect current work practices in industry (Wilson & Zamberlan, 2012).

Gammal (2009) lists the following potential advantages of interdisciplinary education:

- It is reflective of life, which is not segmented into discrete disciplines
- It allows for the use of multiple approaches and applications of skills for problem solving
- It can provide a broader context for new information
- It allows for a broad use of diverse experiences and knowledge bases
- It encourages creativity and creative thinking
- It allows greater flexibility
- It can provide expanded opportunities for the application of theory
- It provides a good introduction and foundation for various disciplines
- It allows for the use of diverse perspectives

- It can enhance the ability to synthesize and integrate information. (pp. 7-8)

The built environment is itself very siloed, with a division of labor or working in specialized fragments including "trades and professions, contractors and subcontractors, designers and makers, borrowers and lenders, and producers and consumers" (Edwards, Campkin, & Arbaci, 2009, p. 7). Clarke and Agne (1997) suggest that when instruction becomes integrative then it also becomes constructivist, which emphasizes not just the mastery of facts, but rather thinking skills. Jiji, Schonfeld, & Smith (2015) found from their experiences that a properly designed capstone course can give "a depth of understanding that complements the broader understandings provided by other coursework" (p. 197).

In 1999, Gann and Salter argued that there is a gap between disciplines-based education in the built environment and what is happening in industry and suggest that interdisciplinary skills are vital to problem solving. Many students entering professions in the built environment do not fully understand the diverse relationships between production, regulation, and management that takes place within the built environment (Edwards, Campkin & Arbaci, 2009). Corkery (2007) boldly suggests that "professional degree programs in built environment disciplines that do not prepare students to work closely with colleagues in other fields will not be meeting their responsibility to prepare graduates who are career ready" (p. 1).

Many barriers to offering an interdisciplinary course exist. There are few standard assessment tools since most assessments were developed for traditional disciplines (Rhoten, Mansilla, Chun, & Klein, 2006). In addition, many departments focus on creating strong introductory courses to attract students to their majors leaving little room for interdisciplinary courses (Oxtoby, 2013).

Katz (2015) suggests that the biggest barrier to implementing interdisciplinary education is faculty, including how they are trained, hired, and rewarded for their "disciplinary research and teaching" (p. 5). Holley (2009) agrees, indicating that most activities and recognition structures are discipline based. Wilson and Zamberlan (2012) note that it requires a change in the way faculty learn, teach and practice research.

At an administrative level, Dubrow and Harris (2006) made the following recommendations for sustaining and supporting interdisciplinary initiatives:

- Encourage upper-level administrative leadership to better seed, support, and sustain interdisciplinary initiatives
- Clarify options for administrative homes and structures for interdisciplinary initiatives
- Re-examine academic policies and practice regarding faculty appointments and promotion to facilitate and reward interdisciplinary activities
- Develop policies and practices that promote the intellectual mobility of faculty over the course of their careers, such as allow them to commit part of their appointment to move their primary appointment to other units, including interdisciplinary initiatives
- Identify and disseminate best practices related to the student experience in interdisciplinary programs
- Identify appropriate additional investments in interdisciplinary program budgets
- Conduct additional research to better understand interdisciplinary faculty and student experiences
- Affirm the shared responsibility of the faculty to prepare future faculty and professionals to cross disciplinary boundaries in pursuit of knowledge and solutions to pressing societal problems. (p. 5)

INTEGRATED CAPSTONE COURSE DESIGN AND DEVELOPMENT

Capstone is an opportunity for students to gather and apply knowledge learned across the curriculum (Jensen & Wenzel, 2001). In order for students to become more multi-disciplined in nature, they need to learn how a real project team would interact and how they would coordinate

efforts while maintaining technical execution (Andersen, Yazdani, Andersen, 2007). Adams (2003) states that multi-disciplinary teams provide an excellent way to promote integration which also allows for students to undertake projects with greater complexity.

Reinicke, Janicki, & Gebauer (2013) state: "Developing an integrated curriculum is not a one-off activity. It is a process that requires an annual review by the faculty who are impacted by it" (p. 14). According to Corkery (2007), interdisciplinary courses challenges both the student and the faculty to work outside of one's normal domain and have need for more communication between colleagues and students. Communication is a major obstacle in the classroom and a major reason that such projects fail (Godemann, 2006). Gammal (2009) suggests that as disciplines become more specialized, they become more isolated from one another and that the jargon within a discipline makes it difficult to promote collaboration. This is further emphasized by Yanik and Hewett (2000) who claim the entire built environment industry has communication issues. As Cortese (2003) observes, "Interactions between population, human activities, and the environment…for a secure, just, and environmentally sustainable future are among the most complex and interdependent issues with which society must deal" (p. 16).

A well-designed course can help students develop new knowledge as they integrate topics from prior courses as well as "refresh students on key discipline topics immediately preceding graduation" (Reinicke, Janicki, & Gebauer, 2013, p. 10). Students have the opportunity to apply what they have learned in their major as well as other institutional courses (Rhodes & Agre-Kippenhan, 2004). Yang (2013) states, "When ideas from different disciplines are taken into account, interactive discussions on an issue and its diversity of thought definitely help make the answers more clear and affirmative (p. 7).

Jiji, Schonfeld, and Smith (2015) recommend that interdisciplinary capstone projects be relevant to real-world issues, be challenging but balanced in efforts made by the students, and in addition, should be interesting to the faculty. Walz and Christian (2017) suggest that faculty focus on the design process which spans all engineering disciplines and focuses more on communication skills, time management, teamwork, decision making and conflict resolution. However, there is a danger of making the course either overly complex or too simplistic (Viterbo, 2007). Research by King and Kitchner (1994) suggest that students mature when teaching has a balance of challenge and support. Castor and Leeds-Hurwitz (2004) state that capstone projects can help students make connections and gain experience that may lead to employment after graduation.

SERVICE LEARNING AND PARTNERSHIPS

While there is little consensus among scholars upon a standard definition for service learning, Bringle and Hatcher (1996) define service learning as, "a credit-bearing education experience in which students participate in an organized service activity that meets identified community needs and reflects on the service activity in such a way as to gain further understanding of course content, a broader appreciation of the discipline, and an enhanced sense of civic responsibility" (p. 222).

As Saulnier (2003) points out, regardless of a non-standard definition, service-learning commonly has three main purposes: "strengthening student learning, benefitting, the community, and focusing on issues of social justice, culture and society as a whole" (p. 6). In addition, Wilcox and Zigurs (2003) feel that "service learning projects and courses provide a means for students to obtain real-world experience in the relatively safe environment of academia" (p. 3). When interdisciplinary courses involve the community, they create an opportunity for students to

understand social issues while gaining a sense of their civic responsibility and ethical relevance related to their discipline (Corkery, Roche, Watson, & Zehner, 2007). Corkery, Roche, Watson, and Zehner (2007) share from experience that "service learning can also be an effective vehicle for interdisciplinary learning situations" (p. 2).

External clients help drive student performance as it allows them to apply their skills and knowledge to benefit the local community (Walz & Christina, 2017). Neutzling (2003) believes that community colleges exist in order to serve the communities which they support and are geared toward teaching and learning. Roueche and Roueche (1977) agree in their belief that community colleges differ from universities in that they focus on service.

Many institutions offer service learning opportunities during a program's capstone course. It is a good way for faculty to see if students have an understanding of course materials (Traynor & McKenna, 2003). Service learning also helps in facilitating community clients in the application of new technical and management knowledge as well as innovative ideas (Alexander, 2001). Students face challenges in applying classroom knowledge with needs in practice and therefore benefit when they are exposed to a real world setting through a capstone course that offers service learning where thinking and judgment can be tested (Wei, Siow, & Burley, 2007).

Many educators within STEM feel that the best way to teach sciences is to engage students in actually doing science (Anderson, Banerjee, Drennan, Elgin, Epstein, Handelsman, Hatfull, Losick, O'Dowd, Olivera, Strobel, Walter, and Warner, 2011). Similarly, Quinlan, Corkery, and Castle (2004) suggest that a key component in service learning is that it is project-based, or experiential learning.

Solnosky and Fairchild (2017) believe that in order for students to truly become more multi-disciplinary, they need to learn how a real project team interacts while coordinating

designs while engaged in technical execution. These real project teams are naturally formed during service learning when the student team has a real-world client or partner. It is generally more successful than when the faculty are the clients. In addition, service learning allows students to develop leadership skills as they work their way through a project (Rose, Meyer, & Hitchcock, 2005). Success comes through a cooperative attitude and trust among instructors and industry partners (Wong, Pepe, Stahl, Englander, 2013).

When it comes to implementing service learning into a capstone project, Wei, Siow, and Burley (2007) share that two main aspects of course design are establishing guidelines and responsibilities and a means of assessment and deliverables. This can be accomplished through weekly meetings, grading, coordination, team meetings, faculty feedback, midterm reports, presentations, and journals.

A well-designed capstone project with an industry or government partner can also excite, inspire, and motivate students (Jiji, Schonfeld, Smith, 2015). In addition, it can increase performance, improve communication skills, be added to student's resumes and discussed during job interviews (Grant, Malloy, Murphy, Foreman & Robinson, 2010). It has also been noted that students have also been better prepared for industry through increased soft-skills development and that even collaborations among students in multiple classes allow them to engage in projects more complex than they might otherwise be able to do in a single semester (Wong, Pepe, Stahl, Englander, 2013).

CAPSTONE PREREQUISITES

Ensuring that the appropriate prerequisites are met before being allowed to sign up for capstone is critical. Students will need to draw upon prior coursework in order to be successful. This is especially true of students in an interdisciplinary course where a student may be the only

representative of that discipline on a team. When designing a capstone course, faculty need to have an understanding of prior coursework and the concepts and skills acquired; many times, these skills are introduced during prerequisite courses and then reinforced during the capstone experience (Reinicke, Janicki, Gebauer, 2013).

Some educators suggest the usefulness of reviewing prior learning at the beginning of a capstone course before starting project through a common assignment to help bring everyone up to date (Reinicke, Janicki, Gebauer, 2013). Jiji, Schonfeld, & Smith (2015) also feel that success is more likely when the course has useful background information related to the project. An instructor needs to plan the problem clearly, provide access to the background information, and give guidance and purpose of the project (Zande, 2007).

TEAMS AND FACULTY

Team dynamics play a major role in the success, or failure, of an integrated capstone project. Walz and Christian (2017) recommend that faculty teach team skills and dynamics including effective management, making sure all voices are heard and all are able to contribute to the process, decision making, and conflict resolution. Team teaching helps ensure that the perspectives of different disciplines are accurately presented to students (Newell, 1983).

One way to model effective teams is having multiple faculty team teach the course (Walz & Christian, 2017). Team teaching, as defined by Davis (1995) is: “All arrangements that include two or more faculty in some level of collaboration in the planning and delivery of a course” (p. 8). Team teaching can also generate enthusiasm for both the instructors and the students (Letterman & Dugan, 2004). The way students interact, combined with their technical and soft skills can alter team dynamics (Solnosky & Fairchild, 2017). MacGregor, Scott, & Borland

(2017) noted, “When teams are working positively together, they can motivate one another to tackle complex problems, help each other develop skills and share learning” (p. 1).

ASSESSMENT

As Rhodes and Agre-Kippenhan (2004) point out, assessment of capstone work can be challenging since there is a need to contextualize student learning because a good assessment will not just look at the final product but also the learning process. Some scholars, such as Black and Hundley (2004), find that capstone has become the primary source regarding the quality of instruction for a program. Davis (2002) states that capstone courses provide a comprehensive evaluation of prior knowledge by students.

Creating a common set of expectations helps to greatly simplify assessment and is most successful when the course goals align with the program assessment (Rhodes & Agre-Kippenhan, 2004). Sum and Light (2010) suggest that by developing capstone assessments that incorporates various forms of assessment including both formative and summative it not only benefits the program but also the student. MacGregor, Scott and Borland (2017) feel that in order for a student to be accountable, he or she must be given the opportunity to review their own work and assess both progress and quality as well as personal growth. This is also supported by Davis (2004) who suggests that surveying students allows for the measuring of program outcomes.

Unfortunately, many interdisciplinary programs use the same assessment techniques used within the discipline, including tests, surveys, and grades (Rhoten, Mansilla, Chun, & Klein, 2006). Eppes, Milanovic, and Sweitzer (2011) recommend the use of detailed rubrics that evaluate how well a student “understands requirements, gathers, relevant information, generates/evaluates alternatives, considers relevant constraints, and chooses best solution” (p. 9).

One form of assessment is critical reflection, defined as "an evidence-based examination of the sources of and gaps in knowledge and practice, with the intent to improve both" (Ash & Clayton, 2004, pp. 27-28). In their work during an experiential capstone project, Gustafson and Cureton (2014) relate that critical reflection is a tool and not a product of learning. When used this way it reminds students that the goal is not the product but to understand and gain a clearer understanding of their discipline and the social and personal context of that knowledge. Bringle and Hatcher (1996) add that this reflection can also help clarify values, but it must be done on a regular basis, and it must be guided. Capstone projects will have diverse deliverables and diverse objectives (Jiji, Schonfeld, & Smith, 2015). Documentation and presentations are both deliverables that should be aligned with core work of the project which should be evenly distributed over the term (Eppes & Milanovic, 2011).

CHAPTER SUMMARY

While there is no single agreed upon definition of interdisciplinary education, perhaps Klein's (1990) definition helps put the pedagogical goal in perspective by stating it is "neither a subject matter nor a body of content. It is a process for achieving an interpretive synthesis, a process that usually begins with a problem, question, topic or issue" (p. 188).

Working as interdisciplinary teams will help students to prepare for industry and allows them to experience the kind of interactions they will encounter in the real world as they strive to solve complex issues related to the built environment. Deploying such a program requires commitment of resources by administration, course development and assessment by faculty, and thinking across discipline boundaries by the students. However, Viterbo (2007) warns that though we live in a complex world with multi-faceted issues that can often be better solved through an interdisciplinary approach, the need for disciplinary training still exists.

Integrated capstone development seeks to create a project challenge that mimics a real-world situation and helps students effectively collaborate between disciplines. It must be balanced in difficulty and challenge. Developing an integrated capstone experience will most likely require the changing of other courses (Reinicke, Janicki, & Gebauer, 2013). Modifications of these prerequisites will better prepare students to work together.

For many capstone courses, service learning is a major component in delivering an integrated experience. For many students, the opportunity to have such real-world experiences provides application for what would otherwise only be abstract theories (Braqbant & Hochman, 2004). In an integrated service learning exercise, students will be working across disciples, often with a real client to help solve an issue within the community.

Most integrated capstone courses are comprised of both student teams and team teaching by faculty. Plank (2013) suggests that team teaching has a positive effect on both students and faculty as both must explore multiple perspectives. Working together across disciplines can result in better project solutions and higher motivation among team members.

Proper integrated capstone assessment is not focused solely on the finished product produced by students, but also the learning experience and connections made among their respective disciplines. In addition, Berheide (2007) suggests that a capstone course allows the assessment of the success of both the program and the institution. This is accomplished by making sure that student deliverables are aligned with program outcomes.

CHAPTER 3: METHODOLOGY

INTRODUCTION

The interdisciplinary course guide in Chapter 4 is based on over a decade's worth of data and refinement in offering an interdisciplinary capstone program for built environment programs at Sinclair Community College. While the guide is current as of this writing, it represents only a snapshot in time. As technologies improve, community needs change, and advisory boards help guide best practices, the course on which it is based within the Built Environment Department continues to evolve and expand.

This chapter addresses the need for a guide, its format and structure, associated expenses, scalability and adaptability, and continual improvement efforts by faculty through analysis of feedback and data collected from students, faculty, and advisory board professionals.

CAPSTONE PRIOR TO THE INTERDISCIPLINARY APPROACH

Prior to implementing the interdisciplinary capstone experience for Architectural Technology, Civil Engineering Technology, and Construction Management Technology programs, Sinclair's Built Environment Department conducted standalone capstone courses. For example, previous projects included the drawing of a commercial building for architectural students, a public park design for civil students, and the development of a project schedule for a construction project for a not-for-profit organization in Dayton, Ohio.

WHY CREATE A GUIDE

For several years, faculty in the Built Environment Department have presented their interdisciplinary capstone work at various conferences around the United States, including Autodesk University in Las Vegas, Nevada, RosEvaluation Conference at Rose-Hulman Institute of Technology in Terre Haute, Indiana, and The League of Innovation Conference in Austin, Texas. These presentations were always well received by attendees who had numerous follow up questions. In addition, administrators at Sinclair Community College and the Built Environment Departments engineering technology crediting agency, ETAC/ABET, have been impressed with the department's unique efforts in offering an interdisciplinary experience at the community college level.

Creating a "how-to" guide will allow other institutions wishing to develop their own interdisciplinary course in built environment programs such as architecture, civil engineering, and construction management, the opportunity to do so using already established best practices and procedures. The information presented is based on numerous interdisciplinary capstone course refinements and modifications.

ADAPTABILITY

Even though the interdisciplinary capstone guide is focused on built environment programs, it is easily adaptable to other academic programs that wish to offer a collaborative experience for their students by focusing on the framework of the course. Many of the best practices presented in planning, development, delivery, and assessment of an interdisciplinary course are applicable to a wide range of disciplines and should require only minimal adaptability.

SCALABILITY

The guide is easily scalable. Faculty will need to balance variables such as number of students on each team, credit hours of the course, needs of the community, and the desired level of involvement and availability of advisory board members in developing projects that are within reach of student achievement. As a starting point, it is generally easiest to alter the scope and depth of the projects being developed to align with team composition and size. In an effort to help guide students throughout the term, maintaining at least one faculty for each discipline represented is highly encouraged.

BUDGET

Offering an interdisciplinary capstone course generally has no significant additional costs to an academic department. Most associated costs in supplies are similar to those incurred in standalone capstone courses. Robust project deliverables such as 3D printing large models for a community partner or printing multiple large format drawing sheets may increase supply costs if these are above and beyond normal course deliverables. Many of these expenses can be offset through donations from an associated community partner.

Faculty costs should also be the same as independent capstone offerings assuming there is only one faculty member needed per discipline. Larger courses where the number of students may dictate more than two student teams per faculty, where additional faculty are used as subject matter resources, or where other faculty are employed to help evaluate students during the midterm exams, may result in additional costs.

COMPONENTS AND STRUCTURE OF THE GUIDE

To help users of the guide in Chapter 4 develop their own interdisciplinary capstone course for built environment programs, the chapter is broken into three sections: Developing an Interdisciplinary Capstone Course, Delivering an Interdisciplinary Capstone Course, and Assessing an Interdisciplinary Capstone Course.

The section on Developing an Interdisciplinary Capstone Course covers the steps faculty and program leads need to consider in preparing to launch a capstone course with multiple disciplines. It includes topics such as development of the program of study, building relationships with community partners, and involving advisory board members. It also covers practical elements such as software, equipment, and supplies that are best to have in place before the course begins.

The section Delivering an Interdisciplinary Capstone Course focuses on how to execute an interdisciplinary capstone course including how to effectively direct and grade student efforts, meeting and gathering considerations, and the various roles of faculty.

The last section on Assessing an Interdisciplinary Capstone Course covers methods that departments might consider to determine if the course is meeting program and institutional outcomes as well as the needs of local industry. In addition, this section covers ways faculty at Sinclair Community College have used the course to help fulfill accreditation requirements.

PRODUCT GUIDE APPROACH AND REFINEMENT

During the course of writing the product guide found in Chapter 4, the interdisciplinary capstone course at Sinclair Community College was offered for two terms, Spring 2020 and Spring of 2021. This allowed the author to directly and immediately make updates to the text to

ensure that the guide was as up to date and included as many facets of the interdisciplinary approach as possible.

CONTINUAL IMPROVEMENT

The "how-to" information contained within Chapter 4 of this product dissertation is the result of hundreds of hours of teaching the interdisciplinary course, reviewing feedback, making adjustments, delivering the course, and repeating. Over the past ten years, the course has evolved from a trial run concept to a robust offering within the Built Environment Department and is generally enjoyed by both faculty and students alike.

The Built Environment Interdisciplinary Capstone course at Sinclair Community College relies heavily on the continuous improvement process to fine tune projects, deliverables, boot camps, midterms, and advisory board involvement. The process itself is heavily based on feedback and comments from students, faculty, and advisory board participants. While all responses are evaluated, including outliers, faculty focus on data trends to make improvements.

IRB APPROVAL

Institutional Review Board approval from Ferris State University and Sinclair Community College to review, evaluate, and present already collected student, faculty, and advisory board comments, observations, and evaluations can be found in Appendix A. No additional surveys were administered nor were any additional interviews conducted for this dissertation.

DATA COLLECTION AND ANALYSIS

Since its inceptions, the Built Environment Department regularly collects and analyzes information regarding student satisfaction and success in the interdisciplinary capstone course.

The four main instruments include Faculty Feedback, Student Exit Interviews, End of Course Surveys, and Advisory Board Feedback from the Interdisciplinary Capstone Dinner and Expo.

While the department does gather some quantitative data from those instruments, the most effective and most often used data comes through direct comments. The comments presented in this chapter have been selected to illustrate the Built Environment Department's commitment to continual improvement. They are in no way an exhaustive representation of all the changes and updates made to the interdisciplinary capstone course since its inception but rather gives the reader an example of how feedback from various modalities can be used to make meaningful changes.

Faculty Observations

During the interdisciplinary capstone course, faculty meet weekly to review individual, team, and discipline progress, upcoming dates and events, action items, and discuss lessons learned. These meetings have been valuable in identify areas of needed improvement while the class is running. The most dramatic changes for the course took place during the early years of its offering, with latter years being more fine-tuning. When possible, changes are made immediately; however, most updates are made in preparation for the next time the course is offered. For example, adding clarifying language to a rubric is easy to make during the term and benefits the students in the current term as well as future offerings. Moving midterm dates to better align with project milestones is an example of an improvement for the following year.

The following selected faculty observations illustrate how changes were implemented to improve the course. The three examples provided range from a major course improvement to fine-tuning.

Observation #1:	Students were sometimes confused about the expectations of assignments and how they were going to be graded. Additional questions like attire or format were often unclear. Furthermore, there were some inconsistencies among faculty when discussing expectations for various assignments.
Solution:	Create a single clarifying assignment and grading rubric document that would strive to answer all potential student questions for each assignment and serve as the master guiding document for the course. Faculty would also create a master calendar that goes hand in hand with the rubric and assignment document to quickly and easily show due dates.
Result of Change:	The assignment and grading rubric document is reviewed at the beginning of the term with the entire class as well as with project teams prior to each assignment due date. Students ask fewer clarifying questions and there is greater consistency among faculty in explaining expectations.
Improvement:	The assignment and grading rubric document continues to help guide capstone students and serves as the backbone document of the course. Adjustments are made to the calendar each term, while other assignment details are altered as needed based on the projects and team compositions that term. A copy of the document can be found in Appendix E of this dissertation.

Observation #2:	Teams are spending too much time in preliminary building and site designs. To have enough time to produce a product with sufficient details, students should be finished with conceptual design no later than Week 3 of the term.
Solution:	Move the design charrette earlier in the term and involve advisory board professionals to review initial design concepts and give suggestions for improvement.
Result of Change:	Students have more time during the term to refine their design solution and are spending less time in conceptual development. Overall, students seem to enjoy meeting with industry professionals to get feedback on their designs and appreciate feedback on how design challenges are handled in real-world applications.
Improvement:	Continue to hold the design charrette with industry advisory board member with the first two weeks of the term.

Observation #3:	Students are not meeting the percentage completion requirements for the midterm presentations. For the four presentations, students should roughly be 25%, 50%, 75%, and 100% complete. The first midterm appears to be too early in the term.
Solution:	Align midterm presentation due dates to allow for more time at the beginning of the term for project brainstorming, sketching, and the advisory board design charrette.
Result of Change:	With more time at the beginning of the term, students overall have been more in line with the project completion percentages, especially for the first midterm presentation.
Improvement:	Schedule was updated mid-term and continued with satisfactory results in subsequent years.

Student Exit Interviews

For the Built Environment Department at Sinclair Community College, student exit interviews are conducted by the department chair for each discipline (Architectural Technology, Civil Engineering Technology, and Construction Management Technology) near the end of the interdisciplinary capstone course. Feedback from interdisciplinary capstone students during the exit interview represents students, in general, who will be finishing their respective programs at the end of the term.

While questions cover a wide range of topics related to a student's tenure at the college and are not specific to the capstone course itself, students often include valuable feedback related to their interdisciplinary capstone experience. Faculty meet together to review and consider each of these comments to help improve the course and focus more on trends than outlier comments. Like faculty observations, student exit interviews have been a major contributor to course improvements.

Current Student Exit Interview questions include:

- What are some of the strengths of courses in your major?
- What are some of the weaknesses of courses in your major?

- What are some of the strengths of the faculty members in your major?
- What could faculty members do to improve the classroom experience?
- What are your feelings regarding the adequacy of facilities in Engineering Technology labs at Sinclair?
- What are your feelings regarding the advising you received from Academic Advisors?
- Did you have an internship experience? If so, please tell us about your experience.
- What are your plans and goals now that you are graduating?
- Is there anything else we should know about your feelings regarding your major that we have not already discussed?

The student comments that follow specifically reference their interdisciplinary capstone experience and have been edited for context and spelling. Following the comments are examples of how faculty addressed the concerns and made improvements to help increase student success.

One theme that was noticed in the interdisciplinary capstone's infancy was the feeling by students that they were not as prepared for capstone as they needed to be. Specific student comments include:

- "After capstone, I find that there were some things I needed to learn in previous courses but didn't learn them."
- "I would like to have seen more of the design experience in the classroom before Capstone."
- "We don't have enough civil 3D classes. I know one civil 3D class has been added in replace of Revit, but once everyone gets to Capstone, the Architecture students have had 2 Revit-specific classes and a couple other classes that use Revit a lot. I would suggest adding an advanced civil 3D course along with the intro course, maybe make it 3 credit hours and use it to replace LEED."
- "In estimating, for example, I would have liked to go over labor rates in more detail. I believe this would have helped with Capstone."
- "More Capstone prep."
- "A lot of intro not in depth until Capstone."

- "Need more exposure to commercial construction."
- "Only until Capstone, did I learn that there was an "Energy Lab" downstairs in Building 11."
- "Capstone has made me realize that there are a lot of gaps in the education I received at Sinclair. I have not been prepared for this type of site-development by my courses."
- "Some weaknesses were not having any knowledge of how to do Capstone."
- "Need more info up-front on demands of capstone."

With this feedback, faculty made improvements and adjustments to prior coursework in order to better prepare students for the rigor and uniqueness of the interdisciplinary capstone experience. Examples of prerequisite coursework changes include:

- Architectural Graphics II: Commercial construction and materials were covered in more depth.
- Construction Estimating: A more robust commercial estimating project was introduced in the course. The use of BIM software was introduced to develop material schedules. In addition, labor rates were covered in more depth for both commercial and residential construction.
- When the capstone design challenge was established far enough in advance, preliminary work for larger projects such as site surveys or basic design concepts were introduced in courses the term prior to the capstone course. Many students in these courses would be in enrolled in the capstone course the following term.

Another trend based on student exit interview feedback was the need for clarification of expectations and assignments. Related student comments include:

- "Improvement: Capstone – official feedback, presentations, journal, timesheets, and expectations."
- "There should be a breakdown in Capstone course, so student knows how much time is needed to spend on each task."

These comments were in line with faculty observations presented in the previous section. To clarify student expectations, faculty developed a robust rubric and assignment document that

covers expectations, how students will be graded, due dates, format, dress and attire, and point values. A copy of this rubric and assignment document is in Appendix E.

In addition to areas of needed improvement, reaffirming student comments have helped to reinforce course structure and its effectiveness in a student's educational experience. Select affirming student comments related to the interdisciplinary capstone course include:

- "Faculty teaching capstone are always available."
- "The internship experience was very helpful in the classroom, and it is a great help with the capstone project."
- "Capstone: Other teams should be in on presentations; real projects are awesome and pose a great experience."
- "Capstone teachers work well together."
- "Liked critiques from advisors for capstone."
- "The courses touch on a little bit of everything-building codes (which came in handy for Capstone)."

In response to these comments, the Built Environment Department has worked to ensure that faculty teaching the course and advisory board professionals that help give guidance and feedback during the term understand the goals and objectives of the interdisciplinary experience and are committed to its success. Faculty also have continued to encourage students to complete their internship experience the summer prior to capstone in order to gain valuable real-world experience in working with other disciplines.

End of Course Surveys

End of course surveys conducted by the college are not mandatory and have no bearing on student completion of either the course or program. Additionally, the completion of the survey does not affect a student's grades nor academic standing in any way. Even with faculty

encouragement and multiple reminders from the institution, not all students complete the survey. Those who do rarely give written comments.

In addition, current policy at Sinclair Community College dictates that only faculty teaching the course receive a copy of the survey after the term has ended for all tenure-track faculty. Neither department chairs nor division deans have access to this information and are not able to review this data in any way unless the faculty are classified as adjunct faculty or on one-year contracts. All information presented in this section has the permission of the respective faculty member to share student feedback in this chapter.

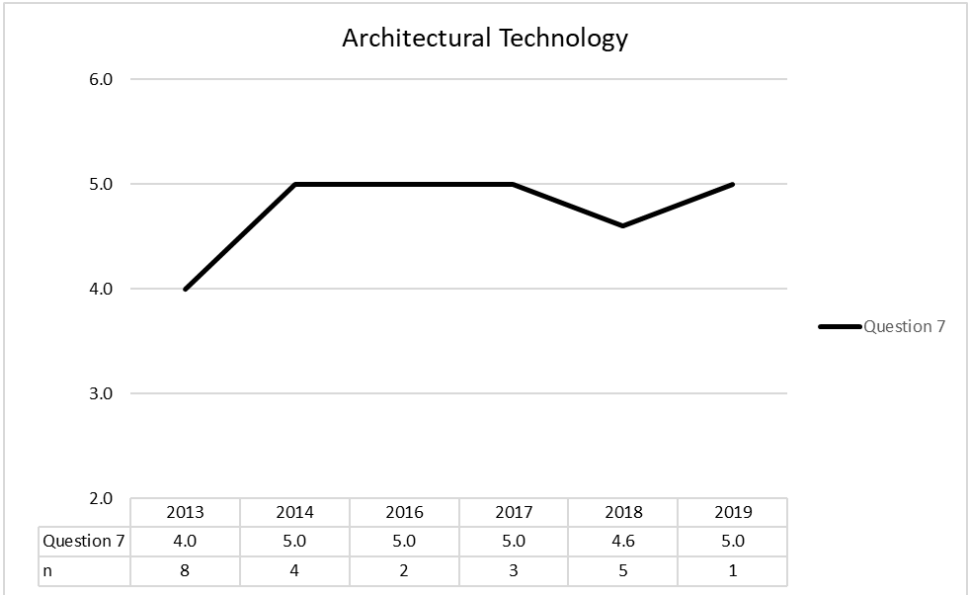
The following institution-wide survey questions at Sinclair Community College are presented to all students who are asked to select one of the following ratings: Strongly Disagree, Disagree, Neutral, Agree, and Strongly Agree. They are reported back to the faculty as averaged numerical values (course mean) where Strongly Disagree = 1, Disagree =2, Neutral = 3, Agree = 4, and Strongly Agree = 5. There are additional questions for online courses. Since the interdisciplinary capstone in built environment has only been offered in a face-to-face format, only questions for face-to-face sections have been included. The questions in bold represent questions that were evaluated for this section.

1. The instructor provided a syllabus that established clear grading policies, objectives, and student responsibilities.
2. The instructor explained course material clearly.
3. The instructor consistently met with the class for the entire scheduled time.
4. The instructor made it easy for me to participate.
5. The instructor treated all students with respect.
6. The instructor encouraged students to engage with course content outside of class.
7. **The instructor established high standards that challenged me to do my best.**

8. **The instructor provided feedback that enabled me to increase my learning.**
9. The instructor returned assignments in a timely manner.
10. The instructor was accessible for assistance outside of class.
11. The instructor stimulated my interest in the topic of this course.
12. I would recommend this instructor.
13. **Time spent in class contributed to my learning.**

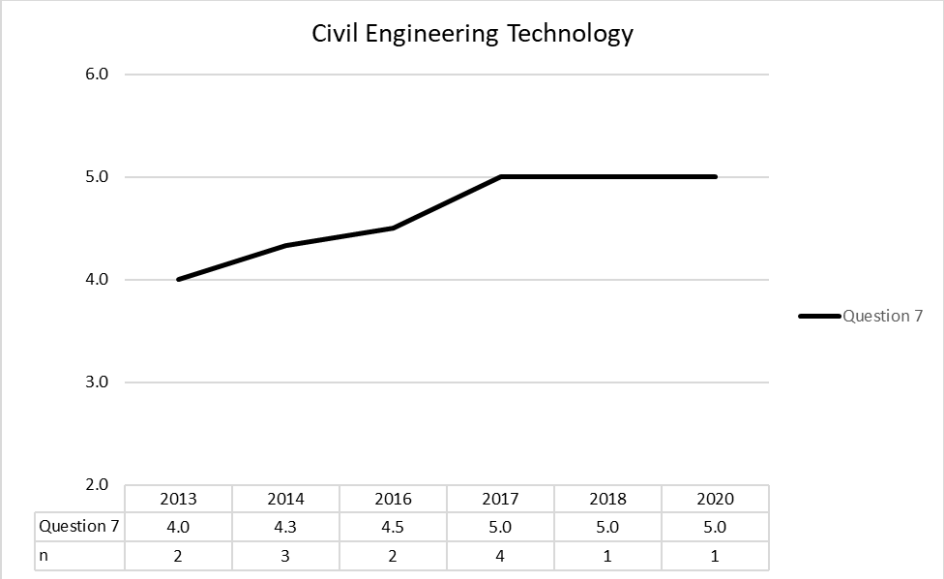
For this chapter, three questions (7, 8, and 13) were selected to graph for the capstone courses in each of the three main disciplines in the interdisciplinary capstone: Architectural Technology, Civil Engineering Technology, and Construction Management Technology. The figures that follow help illustrate a positive increase in student understanding and satisfaction over time as the interdisciplinary course has been refined and updated. The graphs also suggest that there are additional improvement opportunities to make including raising the bar. To simplify the charts, years that had zero student responses were omitted.

Figure 1. Architectural Tech. student responses to End of Course Survey Question 7.



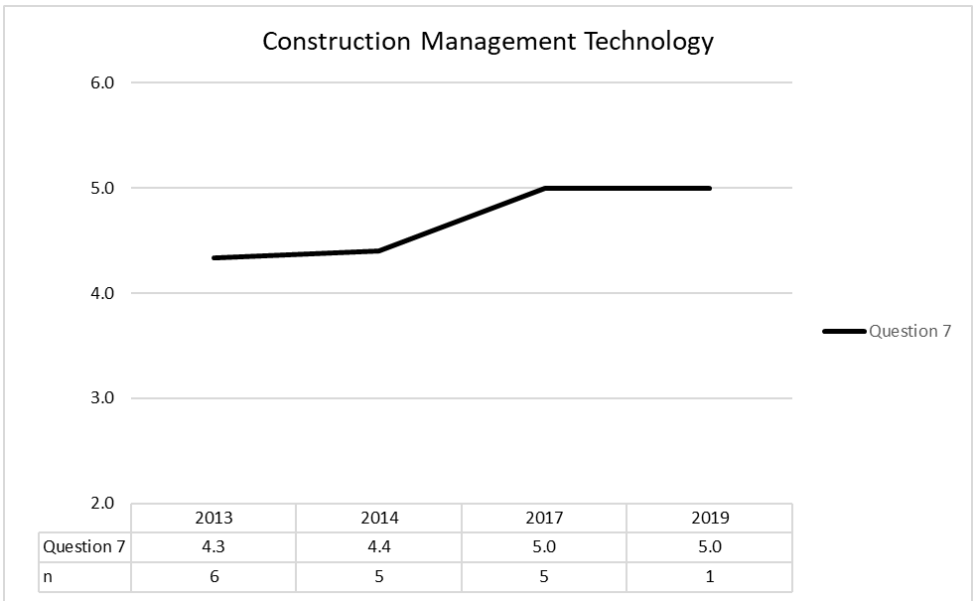
	2013	2014	2016	2017	2018	2019
Question 7	4.0	5.0	5.0	5.0	4.6	5.0
n	8	4	2	3	5	1

Figure 2. Civil Engineering Tech. student responses to End of Course Survey Question 7.



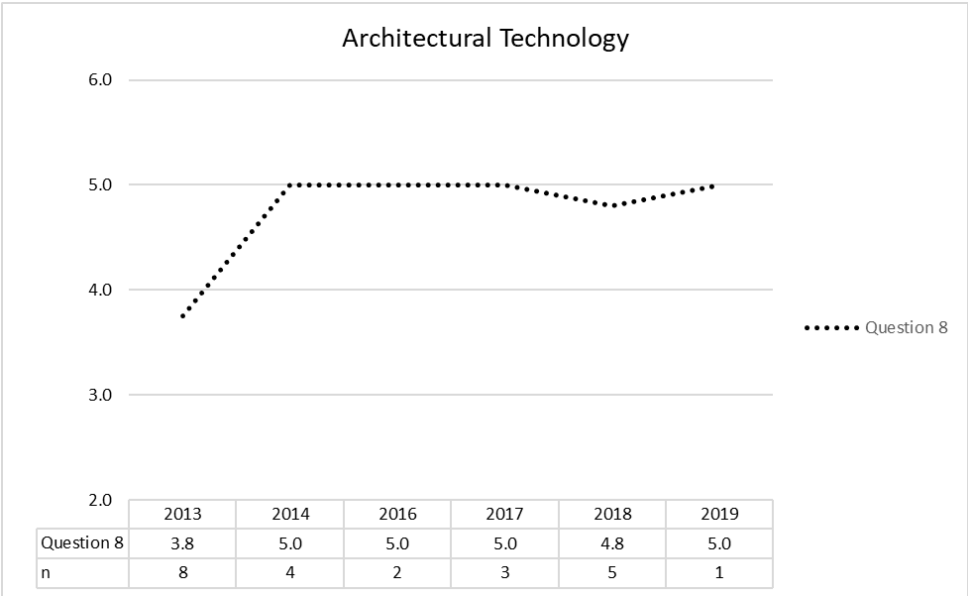
	2013	2014	2016	2017	2018	2020
Question 7	4.0	4.3	4.5	5.0	5.0	5.0
n	2	3	2	4	1	1

Figure 3. Construction Mgt. Tech. student responses to End of Course Survey Question 7.



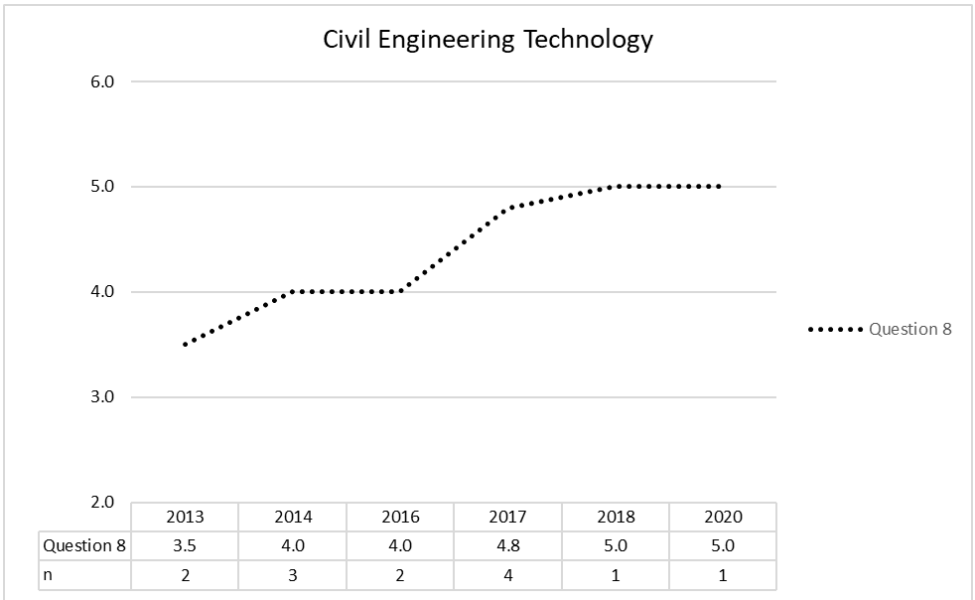
	2013	2014	2017	2019
Question 7	4.3	4.4	5.0	5.0
n	6	5	5	1

Figure 4. Architectural Tech. student responses to End of Course Survey Question 8.



	2013	2014	2016	2017	2018	2019
Question 8	3.8	5.0	5.0	5.0	4.8	5.0
n	8	4	2	3	5	1

Figure 5. Civil Engineering Tech. student responses to End of Course Survey Question 8.

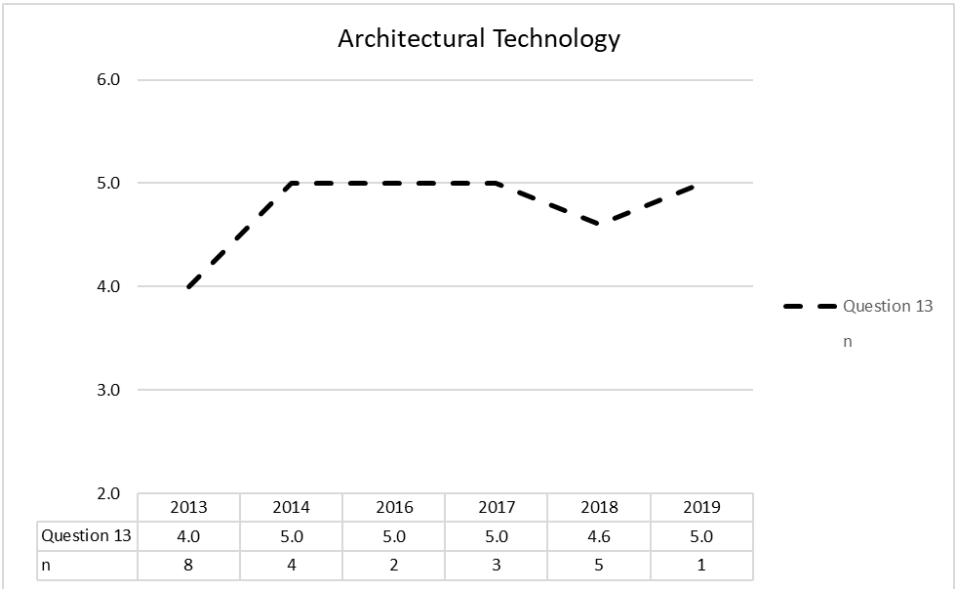


	2013	2014	2016	2017	2018	2020
Question 8	3.5	4.0	4.0	4.8	5.0	5.0
n	2	3	2	4	1	1

Figure 6. Construction Mgt. Tech. student responses to Endo of Course Survey Question 8.

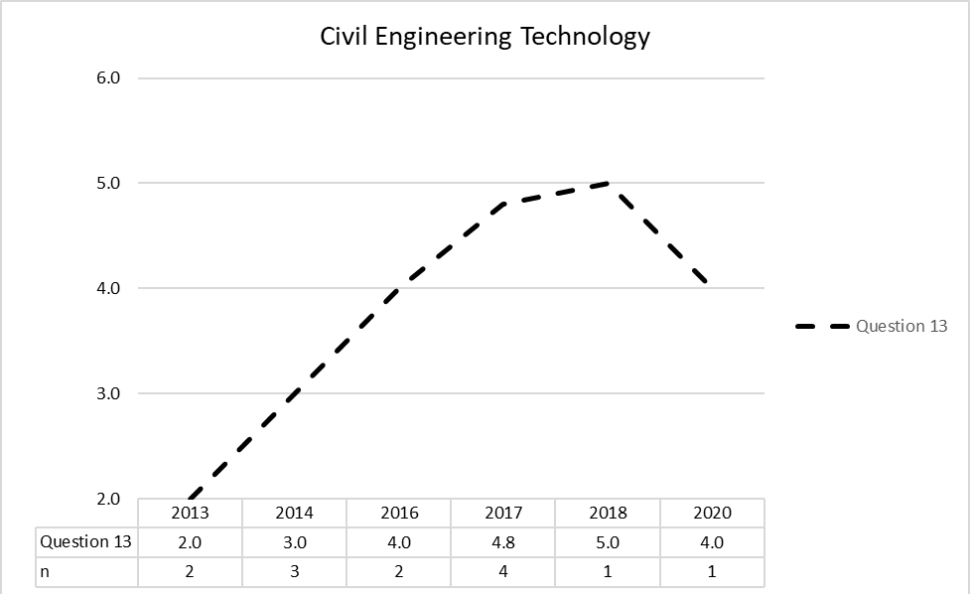
	2013	2014	2017	2019
Question 8	4.8	4.4	4.8	5.0
n	6	5	5	1

Figure 7. Architectural Tech. student responses to End of Course Survey Question 13.



	2013	2014	2016	2017	2018	2019
Question 13	4.0	5.0	5.0	5.0	4.6	5.0
n	8	4	2	3	5	1

Figure 8. Civil Engineering Tech. student responses to End of Course Survey Question 13.



	2013	2014	2016	2017	2018	2020
Question 13	2.0	3.0	4.0	4.8	5.0	4.0
n	2	3	2	4	1	1

Figure 9. Construction Mgt. Tech. student responses to Endo of Course Survey Question 13.

	2013	2014	2017	2019
Question 13	4.3	4.4	4.8	5.0
n	6	5	5	1

Overall, the graphs show a positive increase in student evaluations. Department faculty attribute these increases to refinements and clarifications made to both the projects and the course over time. As faculty became more familiar with the interdisciplinary concept and the

fine-tuning of student projects, they became more comfortable in being able to challenge students as well as give better feedback.

Advisory Board Feedback

During the dinner and expo, advisory board members are asked to rate students on how well they have met program outcomes. This is done using a QR (Quick Read) code found on each team table. This QR code takes the user to a website where they can provide feedback about student teams. This data is collected by Sinclair's analytics office and then delivered to the department several weeks after the term.

The following are selected comments from advisory board members and represent opportunities for improvement:

- The scoring on smartphones is a bit difficult.
- The format was a bit confusing and overwhelming. 12 projects are hard to review thoroughly in the time allotted.
- Fewer speakers and more time to meet with all capstone groups.
- Generally, the students should work on their verbal communication skills, as it is very important to be able to interact effectively across all levels and disciplines (customers, peers, suppliers, etc.).

Faculty addressed this feedback in the following ways:

- To make scoring and comments easier, the department set up laptop computers at the expo that could be accessed by attendees. This allowed people to more easily type responses and not rely solely on smartphones with small keyboards.
- The format of the presentation directly following dinner and just prior to the expo was reformatted to be shorter in length so that there was more time to visit with project teams. Speakers were also asked to keep their comments brief.
- Students were given additional verbal and presentation coaching opportunities to help prepare them to speak with a wide-ranging audience at the dinner and expo.

Most of the comments received from advisory board members are affirmative. Examples of those comments follow:

- "Sinclair never ceases to amaze me; I am very impressed with what you have taught these students."
- "This is my first time at this event and my first exposure to the Capstone projects, but I'm very impressed by what was accomplished. Good stuff. One can only hope the owner does something with this information to improve the area."
- "I have truly enjoyed three years of participation with the Capstone Program and have been thoroughly impressed. Each year seems to get better, and the students continue to impress me with their ability to balance life, school, and work.... Amazing!"
- "Great work! It is great that students have the opportunity to interact with other disciplines and also explain their projects to guest and faculty."
- "Cannot get enough of the commitment to the community. Great presentation, keep it up."
- "Thank you for helping both students and the community understand better the role each plays in successful engine."
- "Very nice event that helps prepare students for the real world where not every answer is handed to them."
- "Excellent job. The information was delivered very well. Although the students had some challenges, they were obviously able to work as a cohesive team to get the project completed successfully."
- "I felt this was the best class I have seen in the last four years, all were engaged, professional, interested, dressed professionally and spoke decently. They presented well and were informative."
- "This is an advanced capstone project!"
- "This was a great thing to see. Real life applications meet the classroom. Great Job!"
- "This was an excellent hands-on project; I was especially impressed with the teamwork demonstrated and how various problems and setbacks were addressed and corrected."
- "Very positive real-life experience for the students."
- "I like the emphasis on working with the community."

- "Fantastic event and impressive students. They are well prepared for future success."

These comments provided by industry professionals have helped endorse the interdisciplinary approach, the rigor of the projects, benefits to the community, and student preparation to enter industry. Faculty continue to recruit advisory board participants to help ensure a wide spectrum of careers and personalities within the built environment.

ETAC/ABET Accreditation Site Visit Feedback

During the 2016 accreditation site visit ETAC/ABET evaluators praised the interdisciplinary capstone work as a strength of the department. Their official letter accrediting the Architectural Technology, Civil Engineering Technology, and Construction Management Technology programs for the maximum time of six years included the following statement:

> …the curriculum has a strong capstone project that integrates related programs (architectural technology, civil engineering technology, construction management technology, and environmental engineering technology). As a result, students work together using skill sets from their respective disciplines to develop solutions to realistic and challenging projects. Often, these real projects developed in collaboration with community partners, like the University of Dayton and local businesses and non-profit organizations. Graduates of the program leave with the benefit of a capstone experiences that allows them to develop skills integrating technical and nontechnical skills similar to those need in industry. (Bergstrom, W. R., personal communication, August 4, 2017)

The Built Environment Department's interdisciplinary capstone course will continue to play a major role in documenting and assessing student outcomes for the foreseeable future. In addition, the interdisciplinary approach gives faculty the advantage of being able to more easily assess prerequisite coursework by seeing how well students perform during capstone as they draw upon their knowledge learned in previous courses.

CHAPTER SUMMARY

Chapter 4 is intended to be used as a guide for institutions and faculty wishing to implement an interdisciplinary capstone course. The course is not stagnant in its design or approach. In order to be most effective, it should be treated as a work in progress both it its format and delivery. Those wishing to implement an interdisciplinary experience in built environment programs should tailor the course to fit the resources of the institution, needs of local industry, and its student population.

CHAPTER 4: HOW TO DEVELOP, DELIVER, AND ASSESS AN INTERDISCPILINARY CAPSTONE COURSE FOR TWO-YEAR BUILT ENVIRONMENT PROGRAMS

INTRODUCTION

A well-planned and efficiently executed interdisciplinary built environment capstone course can be rewarding and fun for both students and faculty. For students, it allows them to showcase their knowledge, work together in teams comprised of friends and fellow classmates, gives them increased experience and confidence, provides an opportunity for them to perform service learning work within the community, and generates talking points for a job interview. For faculty, it provides an opportunity to work more closely with fellow faculty, share teaching and grading responsibilities, explore new projects, work with advisory board members and the community, and more closely mentor students.

This chapter is a roadmap for built environment programs to successfully implement an interdisciplinary capstone course and is divided into three main sections. The first is the preliminary steps necessary to develop and plan the course. These topics focus on the work of faculty that should take place well before the term begins. The second section is focused on the delivery of the capstone and revolves around the project solutions being developed by the interdisciplinary student teams. The final section describes how to effectively assess an interdisciplinary capstone including the evaluation of individual students, student teams, and disciplines.

Each topic is based on the perspective of over a decade of conducting interdisciplinary capstone projects with built environment associate degree programs at Sinclair Community

College in Dayton, Ohio. Departments that teach similar programs to Architectural Technology, Civil Engineering Technology, and Construction Management Technology can use these recommendations as a starting point and in developing an interdisciplinary capstone course that fits the needs of their students, institution, and local industry. To help guide readers that may wish to implement a built environment interdisciplinary course at their institution, a checklist is located in Appendix B.

DEVELOPING AN INTERDISCIPLINARY CAPSTONE COURSE

The decision to develop and deliver an interdisciplinary capstone course should not be made lightly. Development can quickly consume department resources, require significant hours of advanced planning and preparation, and takes full commitment from faculty and staff, the head of the department, and possibly institutional administration in order to be delivered successfully. However, developing and running an interdisciplinary capstone can be an incredibly meaningful experience for both faculty and students.

A well thought out interdisciplinary capstone course that is carefully planned and organized prior to the start of the term will provide a valuable learning exercise for students as well as an enjoyable teaching experience for faculty. Much of the work for faculty will come in advance of the start of the term. It is not uncommon to start planning up to a year in advance by developing projects, forming relationships with project partners, and coordinating with other departments.

It is recommended that the course be conducted in the last term of an associate degree program. Unless there is a large student population enrolled in the programs being considered, the planning workload will usually dictate that this course be offered only one time a year during spring term. This approach allows the student to get as many classes within the degree completed

as possible and then to put into practice what he or she has learned during the capstone course. The interdisciplinary course is also an excellent springboard in preparing students for work in industry and continued education.

Project Development

One of the most important aspects of a successful interdisciplinary capstone, and one that normally will take the longest, is the planning and development of robust projects for the students. This process should take place in advance of the start of the term, especially for projects that include other departments or partners. Projects that involve real clients or that offer a service learning component may take a year or more to plan and organize.

Projects should be interesting to both the student team and the faculty. Faculty must balance designing program requirements that are both challenging but achievable. Projects that build upon student learning up to that point in their academic career, but that are just outside of their comfort zone, can prove to be rewarding for the student team. A well-designed project will be interesting and enjoyable for the faculty as well. Projects that are reused from a previous year should be updated with new requirements and outcomes in order to keep ideas fresh and faculty engaged.

Most interdisciplinary capstone courses will have multiple projects. The number of projects needed during the term is determined by the number of potential students that will be enrolled in the capstone course. One good indicator is to look at the final enrollment numbers for prerequisite courses for each discipline. Having a single faculty member assigned to a team is ideal as it allows the team and faculty member to work closely together.

At a minimum, the following project information needs to be finalized before the start of the term:

- Capstone logo and color (if used)
- Description of the project
- Disciplines represented on the student team
- Faculty advisor assigned
- Outcomes
- Deliverables
- Community partner, client, or service learning information
- Location of project
- Images or graphics of similar projects that help share influence and shape expectations

The number of challenging projects created by faculty are limitless. Nearly all projects are scalable to allow for differences in team size and discipline representation. A couple of project examples that have been used at Sinclair Community College over the past decade include:

- Renovation of an abandoned building to become affordable housing.
- Design of a multi-level shopping complex complete with restaurants, stores, and parking with dwellings on the second and third floors.
- Development of 1000 rural acres into a NASCAR track including all roads, bridges, and buildings.
- Enlargement of a county airport to increase runway length and addition of a large business park.
- Creation of a wastewater treatment facility, related buildings, and infrastructure.
- Design of a dedicated medical sciences building on the college campus complete with clinic and parking.
- Design of indoor pitching and practice facility for local baseball team.

An example of a faculty-developed project poster board can be found in Appendix C of this dissertation.

Institutional Department Partners

The opportunity to partner with departments within the institution should not be overlooked. Opportunities to develop projects that require input or collaboration with disciplines like culinary, aviation, real estate, automotive, and interior design abound. Often working with the home institution can be easier than working with another college or university, since there are typically fewer barriers of communication.

For example, the built environment capstone students could partner with the Culinary program to act as consultants, or even clients, in the design of a new restaurant or bakery. Meeting with Culinary students on a regular basis throughout the term will allow built environment students to receive advice and feedback on items such as kitchen layout, optimal patron seating arrangements, and food preservation requirements.

Other programs, such as Interior Design, could participate in the capstone as members of the interdisciplinary team working alongside the Architectural, Civil, and Construction Management Technology students. Though their primary responsibility might be traffic flow, colors, patterns, textiles, textures, and furniture, their input will affect design, placement, and overall cost of the project.

When including any department outside of the host department, it is important to work out the details of how students will get credit toward their own program. For consultant work by those students not fully participating in the interdisciplinary capstone course, it may be as simple as an assignment within a course. For those that join the interdisciplinary built environment team for the entire term, faculty may want to consider structuring the courses in the curriculum such that it serves as either the capstone course for that discipline or be a substitution for another course within that program.

University Partnerships

Local universities can be a rewarding partner for both students and the department, especially those institutions where community college students may transfer to upon graduation. While university degrees are typically more theory based than the direct application programs found at most community colleges, they can add a new dynamic in solving the project design challenge. This is particularly important when the project (especially one that is service learning in nature) has capability or knowledge gaps that can be addressed by the university partner. For example, if the Civil Engineering Technology program at the community college focuses primarily on-site surveying, students from the Civil Engineering program at the university could help with other topics such as structural engineering and road design.

For students, such a partnership also provides an opportunity to be exposed to a university setting. Holding meetings and presentations on the university campus allow students to interact with university students and faculty, visit classrooms and labs, and use equipment that might otherwise be unavailable at the community college. For faculty, it usually allows for a more robust project design (including additional service learning opportunities), helps share the workload, and creates relationships that may ultimately help with course alignment and transferability. Even if the university is unable to commit for an entire term or length of the project, there may be opportunities to use either students or faculty from the university as consultants.

Collaboration with a university should be started in advance of the start of the capstone course, especially if there has been little departmental collaboration in the past. When a university agrees to work together on an interdisciplinary project, every effort should be made by both institutions to coordinate schedules in order to offer the courses on the same days and at the same times to allow students to more easily meet, work, and coordinate together. Even if the time

overlap is only feasible for a short time, having class at the same general time greatly reduces coordination issues. It is also important to ensure that any software applications used are compatible between the two institutions, especially version number.

Community Partners and Service Learning

Service learning opportunities where students can work with a real client on a real project abound in most communities. Starting points for faculty to explore possible options include reaching out to advisory board members, internship partners, local professional organizations, charities, civic group, and churches.

It is important to consider project scope, distance from the college, and anticipated level of involvement from the community partner when working within the community. All community partners should have an understanding of student and institutional limitations and restrictions, time frame, time commitment on their part, and any anticipated costs before starting. Initially, finding the right community partner with the right project may take time.

It is common that after a few years of running an interdisciplinary capstone that instead of having to find projects with community partners, interested parties will contact the department. Many of their suggested projects may not be at a caliber fit for an interdisciplinary team but might be more suitable as an assignment for another course within the program. Departments should pass on projects that may be too advanced or complex for student teams to be successful in developing a viable solution during in a single term.

Some service learning projects may require approval from both school administration and an institution's legal counsel. All parties might need to sign contracts in order to make sure that the activities the students will be engaged in will mitigate liability or harm for both the students and the school. Such agreements should lay out the scope of work and specify the services

students will render. To help remove school and individual faculty liability, it is highly recommended that the student's final product, even if fully submission ready, not be stamped by faculty holding licensure. Such "sign-offs" should only be done by industry professionals who use student work as an inspirational starting point for official plans and calculations.

Coursework Prior to Capstone

Early planning of capstone projects will allow faculty to identify specific prerequisite courses that may need assignments modified in order to prepare students for capstone. Some of these adjustments, like collaborative work, could become a permanent update to the curriculum while other assignments may be more preparatory to a specific capstone project. These changes should be made to each section of a course that is taught in order to capture all students that may enroll in capstone and ensure they have all had these prerequisite experiences.

Lectures and Labs

The integrated capstone revolves around the concept that students use the knowledge they have gained during study of their discipline to work together to solve a design challenge. In order to give enough time for students to perform research, participate in coordination meetings, and complete their design solution, a successful capstone offering is heavily weighted on lab hours with minimal time for lecture.

Lectures should primarily focus on topics that students need in order to complete their respective projects, but either have not yet been exposed to (because they are not in that discipline), as a refresher, or for a topic that was not covered in as much depth as is needed to develop a successful solution to their design challenge. For example, students early in the Civil Engineering Technology program learn how to do basic water run off calculations to determine

how much water is absorbed before and after a construction. These calculations may be needed during capstone to size culverts, retention or detention ponds, and to influence the choice of surface materials, such as permeable concrete or asphalt. A faculty member may wish to cover this topic with the whole team to help students understand how these calculations will apply to each discipline on the team, such as cost estimating and scheduling.

Student Approval

It is highly recommended that final approval for students to enroll in the capstone course require the careful review of each transcript by the chair of the respective department and discipline faculty and that enrollment is not just an automatic admission for completion of prerequisite coursework. Doing so allows the identification of any potential concerns such as poor marks in a critical course that might imped student success during the capstone. In such cases, it is helpful for faculty and student to meet in person to help determine readiness and set expectations for the course. This will also aid faculty in placing the student on the right team and assigning the student to the right project.

One method that helps with the vetting of students is for the department to make an announcement during fall term requiring that all students wishing to take capstone must visit the department office to sign up for capstone and that no students can register on their own or through an academic advisor. The department can then print each student's academic course evaluation as they register with the office and begin the review process.

Team Formation

Successful team formation is at the core of the interdisciplinary capstone. The disciplines needed on a team are dependent on the scope of the project and the number of students enrolled.

With a little creativity, nearly all projects are scalable and allow for the addition or subtraction of disciplines represented on the team. Having a team with as many different disciplines as possible will create a robust interdisciplinary experience and a well-rounded final product.

The size and scope of the project will determine the number of students and disciplines needed. Team sizes of four to five work well, with any fewer putting a larger than necessary workload and strain on students. Unless the projects have substantial deliverables, teams of more than five or six can create the possibility of unbalanced workloads and frustrated students.

In order to build successful teams, faculty assigned to teach capstone should meet before the term starts to consider discipline, strengths, weaknesses, prior performance, work experience, skillsets, and personalities of each student enrolled. The goal is to create a high performing, diverse team that pairs well with one of the projects. The focus should be on collaboration as much as the potential output of the final deliverables.

Letting students form their own interdisciplinary teams is highly discouraged as most students will want to partner with their friends and create a less skillset diverse team than is necessary for a truly collaborate experience.

Classrooms

For most of the term, a normal classroom sufficient to run software like Autodesk Revit or another BIM package will be the main workplace for students. Where space is an issue, having multiple teams in the same room is acceptable, but it is preferable to have each team in their own classroom. This allows them to freely discuss the project, use tools like the white board and podium computers to project and share ideas, hold team meetings, and meet with advisors and community partners.

For events such as boot camps, midterm reviews, final presentations, and the dinner and expo, rooms should be large enough for everyone to gather without the typical classroom distractions such as computers or equipment. For boot camps, consider having a room large enough for students, faculty, and the presenter to gather as one group. A small conference room big enough to hold capstone faculty and a single student team provides a more intimate setting for midterm reviews.

It is important to remember to reserve all rooms that will be used during the semester. For some events, like a large space for gathering during the dinner and expo, reservations may need to be made up to a year in advance. Meeting at offsite locations, especially at the facility of community partners can help students put into perspective the importance of their work. However, meeting at such a location will need to be balanced with permissions, catering, transportation of students and their work such as models and prints, and computers.

Equipment

Throughout their program of study, students will work with multiple pieces of technology and equipment. For example, Civil Engineering Technology students will learn how to conduct field measuring and layout exercises using auto levels, Philly rods, prisms, total stations, and GPS antennas. All of these items should be fully functional and accessible to interdisciplinary students during capstone. In addition, the well-designed capstone course can serve as a way to determine whether students have mastered various pieces of equipment and technology.

If other courses within the discipline are also being offered on the same day and time as the capstone course, faculty should coordinate availability of equipment in advance. For most interdisciplinary work, tasks like gathering field data through surveying or field measuring is generally done at the beginning of the term with more computer work taking place later in the

term. For more complex projects, faculty may wish to incorporate preliminary exercises in the term prior to capstone.

Software and Computers

Software is an important tool in the collaborative experience. Most of the student's work should be accomplished with up-to-date, industry current software. In addition to the software being used as tools to create the end product, software can also be used for coordination, communications, file sharing, and conducting meetings. Sophisticated software like Autodesk Revit allows team members to be working on the same electronic model from different locations at the same time.

Many built environment software packages have robust computer requirements including the need for fast processors and ample memory. Students will quickly become frustrated if the computers are slow, especially when rendering images or as project designs become more complicated and detailed. It is important that software and computer requests be submitted in a timely fashion so that the software can be purchased, installed, and tested in advance of the start of the course. For many institutions there is a lead time of several months for software and up to a year for hardware. Reviewing the software manufactures website for computer requirements will help with purchasing requests.

At present, the following software titles are recommended, at a minimum, for the built environment interdisciplinary capstone course:

- Autodesk AutoCAD
- Autodesk Civil 3D
- Autodesk Revit
- Microsoft Office (Word, Excel, and PowerPoint)

- Microsoft Project
- Microsoft Publisher

Other software titles that may be helpful depending on the scope of the project include:

- Audtodesk 3DS Max
- Autodesk BIM360
- Autodesk Navisworks
- Blender
- MDSolids
- Sketchup

SUPPLIES

After the capstone projects are developed, it is important to make sure the student teams will have all of the supplies they need to be successful. Many supplies will remain the same from year to year while those projects that are unique or unusual may require additional materials. A list of commonly used supplies used during an interdisciplinary built environment capstone course are found in Appendix D.

LEARNING MANAGEMENT SYSTEMS

Institutional Learning Management Systems (LMS) such as Blackboard, Canvas, and Desire2Learn are an effective way for students to collaborate and share work. Many systems allow teams to be set up by either discipline, project, or both. They also allow faculty to record attendance, track student progress, assign grades, and post information. Such systems can also be used as repositories for student work needed for accreditation or to show compliance.

Assignments and Rubrics

A thoroughly developed interdisciplinary project has a clearly defined set of assignments and rubrics. Like the syllabus, this comprehensive document provides students a detailed set of expectations. For faculty, it provides consistency in messaging among all instructors and a unified guide to grading. To help eliminate confusion, nomenclature regarding this document and the items identified such as midterms and reports should be consistently labeled on the schedule, all drop boxes in an LMS, and the syllabus. Developing a standard set of rubrics, regardless of projects being developed, can also help save time from year to year.

Logo and Color

Developing an interdisciplinary capstone logo and assigning a different color each year can help give a polished look to both faculty and student documentation. Making the logo available electronically, along with the RGB color values allows students to include the logo and color theme on posters, correspondence, slideshow presentations, and prints.

Underwriting

Where permitted, departments may wish to consider finding external donors to underwrite costs of the interdisciplinary capstone course. Underwriting gives departments access to additional funds that can be used to help buy supplies and equipment, take on unique projects that are normally fiscally outside of the reach of the programs, and support the final dinner and expo.

At many institutions, underwriting is handled by the school's foundation office which will help determine ask amounts, send letters and emails to potential donors, and directly handle all donations. Possible donors include:

- Advisory Board Members
- Alumni
- Local Built Environment Firms
- Organizations and Companies that Offer Student Internships
- Retired Built Environment Faculty
- Supporters of the Programs

One method to show appreciation for their gift is to invite donors to the capstone dinner and expo where they will be formally recognized, and their name and logo will be displayed during the event, including the program.

Advisory Board Participation

An active program advisory board comprised of local business interests, craft professionals, and college alumni can greatly enhance interdisciplinary capstone students' deliverables and help reinforce the interdisciplinary capstone approach. They offer students a real-world, professional perspective and can guide students through the iterative design process.

It is important that the right advisory board members are invited to help with capstone. Establishing student collaboration meeting and project review dates in advance of when they will be needed to participate is important in order to be respectful to the board members busy schedule and for consistency with the student teams. Advisory members may need to be reminded that students are being asked to develop deliverables such as architectural plans, cost estimates, project schedules, site plans, and a binder full of project notes and meeting minutes in a single term. Real-life projects of the same magnitude may take years to develop. The students' work will not be perfect, but working across disciplines should be a major outcome of the course.

Most built environment associate degree programs prepare students to enter the career field as technicians, often working under architects, engineers, or project managers when they graduate the program. As board members meet with students during capstone, their focus should be on collaboration, resolving design issues, and directing student decisions and less on theory or detailed aspects of the discipline.

DELIVERING AN INTERDISCIPLINARY CAPSTONE COURSE

Depending on program structure, it is likely that most students will not have had much experience working with other students outside of their own discipline. Even if students have worked together on projects in the past, it will most likely not have been at the depth or breadth at which they will be expected to perform for the interdisciplinary capstone experience.

Students may feel both an uneasiness in working outside of their comfort zone on a larger than normal project and graded, in part, by work produced in concert with other students from other disciplines. A well-developed course schedule, complete with milestones and due dates, combined with clearly defined project deliverables will go a long way in easing tensions. In addition, regularly sharing positive examples of high performing interdisciplinary teams within the built environment can help motivate and excite students about the capstone course. These examples can come from faculty experiences or guest speakers from industry.

TIME COMMITMENT

Even though a collaborative capstone may meet a couple of times a week for several hours, students will need to spend a considerable amount of time outside of the classroom working on the project in order to complete the required deliverables by the end of the term. Activities such as team meetings, faculty meetings, client meetings, information and data

gathering, boot camps, and midterm presentations, can leave little time for actual design work and performing of calculations. Faculty will most likely need to reinforce the idea of working outside of class throughout the course and should be careful to not overschedule students during the term. Given that the nature of the course is working across disciplines, it is highly recommended that attendance is mandatory.

Kickoff Meeting

Not everyone in an integrated capstone will know each other, especially if different programs are housed in different areas of the college. The first class meeting is an opportunity for students to get to know a little something about each other through simple introductory exercises. All faculty members participating in capstone should attend, introduce themselves and give some background, and present preselected portions of the opening presentation.

Having a gathering space with enough room for everyone is important. This first gathering location is generally a comfortable lecture hall different from the same location they will be working in every day. It is helpful to select a location, when possible, that is free of distractions, such as computers and noisy equipment, so faculty can explain the integrated approach, review the rubrics and assignments, review each of the projects, establish teams, and answer questions. This kickoff meeting sets the tone for the term, establishes expectations, and allows faculty to cover important course information such as the syllabus and schedule with the group as a whole.

Team Leadership

It is highly recommended that the team select their own leader rather than having it assigned by faculty. A good team leader will need to balance leadership responsibilities with the work they need to complete related to their discipline. Team leader responsibilities include:

- Communicating with community partners
- Communicating with university partners
- Delegation of duties
- Finding consensus among team members
- Keeping the project team on task
- Leading team meetings
- Preparing meeting agendas
- Setting and obtaining project development milestones
- Tracking assignments and due dates
- Working across disciplines

Team leaders may need basic leadership training in order to be effective and efficient. This can be accomplished in a specialized boot camp or through one-on-one coaching from faculty. The primary skills needed include communication, organization, delegation, and coordination. For example, since the team leader is expected to communicate with other groups like a community partner, it is important that the leader compile a list of questions that can be asked all at once rather than bombarding those organizations or individuals with questions multiple times a week.

ASSIGNMENTS

The overarching goal of a built environment interdisciplinary capstone course is for students of multiple disciplines to come together as a cohesive team and answer a design challenge. Faculty should grade student work through the lens of interdisciplinary interaction.

The following suggested categories can be used to organize student progress during the course and are based on ten years of conducting and refining the interdisciplinary capstone course with built environment programs at Sinclair Community College. Some of these assignments are completed and graded as a team, some are individual assignments, and some are both. These categories are designed to guide student progress and achievement and help create a standardized format for faculty grading. A detailed explanation of each topic will follow. In addition, the assignment and grading rubric document used by the Built Environment Department at Sinclair Community College can be found in Appendix E.

Suggested assignment categories include:

- Weekly Time and Activity Reports
- Weekly Team Progress Meetings
- Resume – Draft & Final
- Midterms – Faculty
- Midterm – Advisory Board and Faculty
- Team Journals
- Team Deliverables
- Final Presentation – Faculty and Classmates
- Dinner and Tradeshow

Weekly Time and Activity Reports

Time and activity reports are an individual student's weekly submission to track his or her hours both in and outside of the classroom as they work on their respective projects. These reports are used to accomplishing multiple tasks. First, it mimics the practices many students will see in industry by built environment firms who track projects and bill at an hourly rate. Second, it allows faculty to see the amount of time a student is committing to the project and helps determine if the student needs to put in more effort. Third, it allows faculty to capture the aggregated number of hours dedicated to a project for easy presentation to the community partner or when reporting the results of a service learning project.

Faculty will find value in creating a standardized form with dropdowns to capture the general area of work. An example of this form can be found in Appendix F. These forms can easily be modified depending on the project and makeup of the team but generally should include the following areas:

- Administrative
- Class Period
- Computer Aided Design
- Other
- Research

In addition to inputting hours completed, students are also asked to estimate the number of work hours they will be spending on the project the following week as well as any needs they anticipate having such as software, reference materials, equipment, or consumables. This allows faculty to guide student's efforts and to make sure those needed items are on hand and ready for students.

There is also a section of the report for students to include a brief personal reflection. This personal reflection is a chance for each student to assess their work to date, assess the functionality of the team, and express any concerns or issues. Students are highly encouraged to voice their opinions and concerns, which allows the faculty to monitor team dynamics and to address issues early. Having the form submitted electronically through a learning management system helps keep the form private and visible only by faculty.

Weekly Team Project Meetings

Project team meetings provide interdisciplinary student teams an opportunity to report progress regarding their project to their assigned faculty member. Held weekly, students should be encouraged to collaborate, discuss design issues, resolve conflicts, and ask for faculty direction. Holding the meeting at the beginning of the week will help keep students on track for the rest of the week. This meeting should be led by the team leader who develops and uses an agenda that includes a status update from each discipline. A team member should take notes, which will become part of the team's project binder.

Resume – Draft and Final

Since most students in the interdisciplinary capstone will be graduating at the end of the term, it is a good time to have them develop or update their resume. In addition, having a resume that is ready to go may be useful to students who make connections with employers at the dinner and expo. It is recommended that the student's draft version is reviewed by the institution's writing center or community engagement office for feedback, corrections, and edits. Full credit for this draft assignment should be given regardless of markups, content, or formatting issues.

For the final version of their resume, students make the necessary changes and improvements and submit via the learning management system. Each resume will be unique, and

faculty should consider giving a great deal of latitude for content and formatting while grading this assignment, focusing more on issues like content, spelling, punctuation, and grammar.

An additional benefit of having students develop a resume during capstone is the opportunity for the department and faculty to share, with permission, resumes of recent graduates with potential employers.

Midterms – Faculty

In Sinclair's interdisciplinary capstone projects, midterms represent major milestones of project development throughout the term. They provide an opportunity for student teams to give status updates on their project and allow faculty to ask questions, steer students efforts, give encouragement, express concerns, and clarify expectations. Three midterm review sessions during the term provide adequate analysis of student work without being overwhelming to students. Each of the three midterms represent approximately 25%, 50%, and 75% completion of the project.

The first and third midterms are with faculty only. The second midterm is with faculty and includes select advisor board members. In order to help focus student presentations, the use of slideshow software is discouraged. Instead, poster board presentations allow students to display current examples of their work while verbally narrating major accomplishments to date. A poster board presentation using a 24" x 36" foam core board is just large enough for each discipline to display pertinent information regarding their involvement in the project but small enough to limit the amount of extraneous information often found in slideshows.

Before developing their board, students will most likely need guidance on using images, limiting the amount of text, and choosing appropriate font sizes for a faculty audience that is approximately ten feet away. Preparing the poster board using software and a plotter will help

create a professional, unified look to the presentation. This plot sheet can then be glued to the poster board with spray adhesive and used as the basis for the narrative during the review.

During the presentation, all team members should have an opportunity to speak for a predetermined time set for the entire team with questions and answers following. For the first review, it is recommended that students begin with discipline introductions, an overview of the project, community partner information, location, and their design process. In an interdisciplinary format, the collaborative process among disciplines is equally important to the product. In order to allow more time for more a detailed update during the third review, faculty may wish to have students forgo an overview of the project and community partner information unless something has significantly changed.

Having a means to record faculty comments and notes during the presentations is helpful and can serve as a basis for the next project team meeting with faculty. All faculty should participate in grading the students. An example of an interdisciplinary capstone grading rubric can be found in Appendix G.

Midterm – Advisory Board and Faculty

The second midterm review is with the student project teams, the faculty, and select advisory board members. It is encouraged that those advisory board members that participated in the design charrette (discussed later in this chapter) be invited to the second midterm review, which represents approximately 50% completion of the design challenge. Advisory board members are often eager to see how their recommendations have been incorporated into the project. While students should not be required to accept all recommendations by advisory board members, they should be prepared to politely and professionally defend their design decisions if they moved in a different direction.

It is helpful to have both faculty and board members use the same standardized grading rubric that allows for comments. While most advisors will feel comfortable helping grade students and tend to be reasonable and positive, those that are overly critical may need to have their evaluations tempered by faculty.

Team Journals

One of the goals of any capstone course within built environment programs is to replicate the data collection and storage of research materials, designs, sketches, notes, and calculations conducted for a project. For the interdisciplinary capstone course at Sinclair, students are asked to compile all discipline information into a single team binder organized by disciplines. In order to remain confidential, student timesheets, which contain open-ended personal reflections, are not included as part of the journal. This physical binder is submitted to faculty regularly during the term for review. The following items can assist teams in collecting and organizing documents and help make the journal a useful resource for students to reference and record progress:

- Calculations
- Client meeting agenda, notes and assignments
- Code information
- Code research
- Discipline meeting agenda and notes
- Midterm feedback
- Partner information
- Pricing
- Renderings
- Sketches

- Team calendar
- Team contact information
- Team meeting agenda, notes, and assignments
- Team project details
- Vendor and supplier information

Team Deliverables

Team deliverables build upon the deliverables suggested by faculty as displayed on the faculty-developed poster boards. An example of a faculty-developed poster board can be found in Appendix C. They are more specific and help guide student teams on their efforts throughout the term. During the first or second class meeting, faculty could consider having student teams start their work by developing a set of deliverables based on their specific project. Examples of built environment deliverables include:

- Code Review
- Cost Estimate
- Elevations
- Floor plans
- Foundation Plans
- Grading Plans
- Project Schedule
- Reflected Ceiling Plans
- Renderings
- Revit Walkthrough
- Roof Plans
- Schedules (Room, Door, Window, Fixture)

- Section Views
- Specifications
- Storm and Sewer Plans
- Storm Water Pollution Prevention Plan
- Three Phase Job Site Layout Plan
- Utility Plans

Final Presentation – Faculty and Classmates

The final presentation is a way for all students in the course to come together as one class and see the accomplishments of each interdisciplinary capstone project team. Prior to this presentation, students will have only presented to faculty or advisory board members during the midterm reviews. A combined presentation to the entire class allows both faculty and students to ask questions and give feedback.

Since students will be presenting to all of the other capstone teams, poster boards are generally too small to be effective. Slideshows with tight guidelines as to number of slides, content, and time will help teams to deliver a presentation that is clear, informative, and succinct.

Dinner and Exposition

Celebration of student accomplishments and displaying of their work can take place in many forms. A formal dinner and expo at the end of the interdisciplinary capstone course is a nice way to celebrate the achievements of students and gives them a chance to talk about their experience with advisory board members, school administrators, and guests. Food costs generally prohibit attendance by families and friends of students, though they could be invited to the expo following the dinner. It is often helpful for faculty to share details and expectations about this event during the kickoff meeting at the beginning of the term.

Formal slideshow presentations during the expo are discouraged. Instead, students are encouraged to talk with attendees about the project, their contributions and deliverables, the interdisciplinary experience, and their future plans.

An efficient layout for the expo can be modeled after a tradeshow format with tables set up for each team to display their deliverables including architectural plans, civil plans, construction estimate, project schedule, phased site plan, midterm poster boards, models, and materials. Where possible, departments are encouraged to provide laptop computers and monitors for each team in order to display select student work or building walkthroughs powered by the BIM software.

A faculty-developed seating chart for dinner will allow faculty to strategically place students among attendees in order to facilitate interaction with students from multiple disciplines. Organizing the seating by project teams or discipline is discouraged as this leaves little opportunity for a wide range of discussion.

Invitations to the dinner and expo could include:

- Administration
- Advisory Board Members
- Capstone Students
- Department Faculty
- Potential Future Partner Department Representatives
- Potential Future Service Learning Partners
- Select Alumni
- Service Learning Partners
- Staff and Lab Technicians
- University Partner Students and Faculty

A sample dinner and expo agenda can be found in Appendix H.

Boot Camps

Boot camps are short, focused lectures for all students in the capstone course. They help to introduce or reinforce topics related to the course, employment, or industry. These presentations can be especially beneficial to students if the topic has not been covered in prior coursework and should be held during the time students are normally in class. Examples range from professional development, such as interviewing skills, to technical training regarding image layout when creating a poster board presentation. These camps should generally be no longer than one hour in length and are usually presented by staff or faculty outside of the integrated disciplines. For example, a staff member from the college's community engagement department could present how to write an effective resume or faculty from the graphic design department could talk about how color choices within a building affect moods.

Design Charrette

It is helpful to have a design charrette within the first two weeks of the term. During a charrette, which typically lasts about two hours, students work with advisory board members who are professionals in their respective fields to give feedback on their preliminary designs and discuss the real-world feasibility of the student-developed design ideas and concepts. Students should be professional, ask questions, listen intently, take detailed notes, and thoughtfully consider the counsel they receive about their proposed design.

In preparation, students should research and brainstorm preliminary design ideas through bubble diagrams, basic sketches, and conceptual layouts on the given project site while following

the predefined list of requirements set by the faculty. Students should be encouraged to use the iterative design process to refine their work in preparation for presenting their ideas.

Only advisory board members who will offer encouragement and interact well with students should be invited to participate. Unless a project is complex, one professional per interdisciplinary project team is typically sufficient. Faculty should prepare advisory board members in advance by reminding them of their role in helping focus and vet the ideas of an interdisciplinary team that only has a single term to complete the project.

Viewing Prior Student Capstone Work

It is likely that capstone will be a student's first course where he or she will be working on teams comprised of students from other disciplines for an entire term. In addition to the confusion that may come when starting a new course, having to work as a high performing interdisciplinary team adds a layer of complexity and uncertainty for the students.

In this setting, it is common for students to ask to view examples of prior coursework to get an idea of how to accomplish a task. However, even when the projects themselves are unrelated, student have the tendency to reproduce the format and look of prior work with little to no changes or improvements. It is far better to direct students to industry practices and professional drawings and documentation than prior student work. The interdisciplinary goal is to help students rely upon those on their team by drawing upon their specific discipline training.

Faculty Roles

Assigning each faculty member a team (or two at the most) will help anchor the project and give students a resource in which to ask questions and help guide decisions. An assigned faculty can help steer the team's approach, coordinate resources, and act as a liaison with a

community partner when appropriate. For projects that are not service learning, the faculty assigned to the team can also act as the client.

For projects that are heavy on one particular subject or that are highly technical, assigning a faculty member who primarily teaches or has expertise in that area can be helpful. For example, a project that requires a lot of complicated site civil work is best served by a faculty member whose primary training and credentials are in the civil engineering field.

Faculty Meetings

Holding weekly faculty meetings is an effective way to help identify interdisciplinary team, project, and discipline issues as well as an opportunity to discuss individual student and team successes and challenges. In addition, faculty can coordinate grading, task assignments, and logistics for events like the midterm review with advisory board members or the dinner and expo. Holding this meeting once a week prior to the start of class can help with the dissemination of information from faculty to students. Furthermore, the meeting serves as a venue for addressing course improvements and collecting ideas on potential projects for the future.

An efficient faculty meeting agenda includes the following items:

- Previous Meeting Review – reporting of faculty assignments from previous meeting
- Project Reports – each faculty reports on the project progress of their assigned team
- Team Reports – each faculty reports on the harmony of their project team
- Discipline Reports – each discipline faculty reports on the progress of their respective discipline
- Grading and Assignments – discuss grading and review of upcoming assignments
- Lessons Learned – discussion about what could be done to improve the course in the future or current term, if possible
- Review of Term Calendar – review of upcoming events and logistical information

- Tasks – review of assignments made and their due dates

Discipline Meetings

Faculty will likely find that discipline related issues on one team will also exist on another team. A discipline meeting is an efficient way for faculty to answer similar questions at once among all students of that discipline. For example, a capstone faculty member who teaches in the construction management program will meet with all Construction Management Technology students to clarify the format for the cost estimate. These meetings should occur several times throughout the term.

Apparel

One method for creating a unified look among capstone students is to give them school or department branded apparel displaying the capstone logo, color, and year. Items such as quality polo shirts can also be used to satisfy business casual dress requirements for certain assignments such as the advisory board capstone presentation or when meeting with community partners. Having students wear something branded for the capstone also presents a nice opportunity for a group photograph. Collecting shirt sizes at time of registration will usually allow sufficient time to receive delivery before the first midterm.

Surveys

Student surveys are an effective way to get a pulse of the interdisciplinary capstone students and can help to identify areas of concern or used to help refine the course. It is easy to over-survey students by constantly asking them for feedback. Student responsiveness will quickly diminish if they are surveyed more than a few times per term. It is highly recommended

that surveys are minimal, concise, and scheduled. A thoughtfully developed survey, which asks the right questions, may also assist in accreditation and compliance reporting.

Models

Many clients, including community partners, will be unable to visualize the final project in 2D form using only paper blueprints. Using Building Information Modeling (BIM) software, like Autodesk Revit, allows students to take advantage of sophisticated rendering features that take static views of the work and create near photo quality images. In addition, walkthrough features allow students to create short videos from the perspective of someone walking around the site and throughout the building.

Physical models, such as those made out of foam core board or made on a 3D printer, can also enhance the experience for both the students and the client. Some clients may wish to take these models back to their organizations to share design concepts or help with activities like fundraising.

Each of these visualization tools (renderings, walkthroughs, foam core model, and 3D print) will take time away from the actual design of the final product and seems to work best on larger teams where someone can be dedicated to their creation. For 3D printing, the electronic model will likely need to be heavily manipulated (walls and floors thickened and glazing removed) as a separate file in order to print properly.

Program Open House

The interdisciplinary capstone course provides an excellent opportunity to highlight the work of students and their respective programs to potential students and their families. Hosting a department or program open house on the same day and time as the capstone course allows

future students to see the facilities, talk with faculty, see the technology used within the disciplines, and most importantly, an opportunity to speak with capstone students about their personal educational journey and their experience within the program.

If interdisciplinary capstone students are invited to participate, it is wise to prepare them in advance by giving context of the event, suggesting talking points, and encouraging them to share positive educational experiences with potential students. It is also important for faculty to remember that time spent by capstone student visiting with those potential students is time capstone students will not be spending on their project.

ASSESSING AN INTERDISCIPLINARY CAPSTONE COURSE

Assessment is a major component of continual improvement and will allow faculty to evaluate their effectiveness during the interdisciplinary capstone. While much time will be spent assessing the performance of students and their work, it is also valuable to evaluate the performance of faculty, the interdisciplinary course structure, the approach, days and times offered, facilities, team projects, the community partner relationship, and the assignments rubric. One way to do this is to identify issue of needed improvement at weekly faculty meetings and look for ways to improve both the course while it is running as well as make improvements for future offerings. Examples of needed improvements include clarification of team projects and student deliverables, enhancing advisory board participation, and strengthen involvement with a community partner.

The first offering of an integrated capstone will not be perfect. Even with best efforts in planning, situations will arise that will require faculty to respond to unanticipated challenges throughout the term. Incorporating solutions to these issues into each subsequent offering will

allow the course to evolve over time and become more personalized and streamlined for the programs, and powerful for the department, institution, and community.

Exit interviews, end of course surveys, and feedback from advisory board members does little good unless it is carefully reviewed, considered, and acted upon. It is highly recommended that interdisciplinary faculty create a formal process for reviewing feedback and making changes. It is important to remember that there will always be positive and negative outlier comments and suggestions. The key to continually improving the interdisciplinary capstone course is to look for trends and themes, especially over time through multiple offerings. In order to get a consistent reading, faculty should ask the same or similarly worded questions from year to year.

Exit Interviews

Since most capstone courses are taken during the last term of a student's time in their respective program, it is an excellent opportunity for the department to interview students face-to-face by discipline. This is often best achieved by a neutral party discussion leader that is not teaching the interdisciplinary capstone course, such as the chair of the department.

To encourage open and honest feedback, the interviewer should make it clear that all student responses are anonymous and that the results of the interview will not made known to the faculty until after grades are posted for the term and that all data gathered will be aggregated, with no student identifiers included in the responses. In addition, students should understand that feedback has absolutely no bearing on current or future grades, completion of courses in which they are enrolled, or eligibility for graduation. Setting this tone at the beginning of the meeting will help students feel comfortable in giving candid feedback.

During an exit interview, the department might wish to receive feedback beyond the interdisciplinary capstone course. Questions may prompt students for responses about the layout of the program, the effectiveness of faculty, the state of lab equipment, alignment of lab exercises with lectures, internship experiences, campus support services, and academic advising. Many of these questions will be outside of the interdisciplinary capstone course itself but help provide a broad-spectrum view of the entire program which may point to issues that will help students be more successful during capstone. For example, consistent student comments about the misalignment of labs in a capstone prerequisite course might help explain poor performance in that area during capstone.

The following exit interview questions are asked of all Built Environment students at Sinclair Community College while enrolled in the interdisciplinary capstone course and serve as a starting point for more in-depth discussion with each discipline:

- What are some of the strengths of courses in your major?
- What are some of the weaknesses of courses in your major?
- What are some of the strengths of the faculty members in your major?
- What could faculty members do to improve the classroom experience?
- What are your feelings regarding the adequacy of facilities in Engineering Technology labs at Sinclair?
- What are your feelings regarding the advising you received from Academic Advisors?
- Did you have an internship experience? If so, please tell us about your experience.
- What are your plans and goals now that you are graduating?
- Is there anything else we should know about your feelings regarding your major that we have not already discussed?

Providing the students with a copy of the questions beforehand will allow students time to consider their responses. Results of select exit interviews conducted during the interdisciplinary capstone course are located in Chapter 3 of this dissertation.

End of Course Surveys

In addition to department exit interviews, Sinclair Community College conducts end of course surveys for each course section every term. Aggregated data from these surveys are used in various reports and reviewed by the school's assessment committee to help ensure quality instruction. End of course surveys are made available to the faculty that taught the course after the term has ended and grades have been submitted. Like the department exit interviews, looking for trends is more important than a single comment or rating (positive or negative) made by a student.

The following institution-wide survey questions at Sinclair Community College are presented to all students who are asked to select one of the following ratings: Strongly Disagree, Disagree, Neutral, Agree, and Strongly Agree. They are reported back to the faculty as averaged numerical values (course mean) where Strongly Disagree = 1, Disagree =2, Neutral = 3, Agree = 4, and Strongly Agree = 5. There are additional questions for online courses. Since interdisciplinary capstone courses work best face-to-face, only questions for face-to-face sections have been included in the questions listed below.

- The instructor provided a syllabus that established clear grading policies, objectives, and student responsibilities.
- The instructor explained course material clearly.
- The instructor consistently met with the class for the entire scheduled time.
- The instructor made it easy for me to participate.

- The instructor treated all students with respect.
- The instructor encouraged students to engage with course content outside of class.
- The instructor established high standards that challenged me to do my best.
- The instructor provided feedback that enabled me to increase my learning.
- The instructor returned assignments in a timely manner.
- The instructor was accessible for assistance outside of class.
- The instructor stimulated my interest in the topic of this course.
- I would recommend this instructor.
- Time spent in class contributed to my learning.

Student responses to the following open-ended questions are reported back to the faculty exactly as answered by the student:

- What were the most positive qualities your instructor possessed as a classroom teacher?
- If you have suggestions for how your instructor can be a more effective teacher, please provide them.
- Please offer any other comments you would like to make about your instructor.

Results of select survey institutional surveys are in Chapter 3 of this dissertation.

Advisory Board Assessment During Dinner and Expo

Assessment by advisory board members during the dinner and expo is an efficient way to determine how well students are meeting course and program outcomes, as well as how prepared they are to enter industry or continue to a four-year institution. An easy way to accomplish this assessment is by have a unique QR (Quick Read) code at each student team table that attendees can scan with their smart phone. (The QR code should be unique to each team and can be derived by using any number of free QR code making websites that generates the code after

submitting a web address.) This QR code is linked to a website that takes users to an online survey with specific questions regarding each discipline within that team. The survey itself can be developed by using a number of online survey sites or, if possible, through the institution's internal institutional research office. It is highly recommended that the survey questions remain consistently worded from year to year to make it easier to identify trends in the response data.

For the Built Environment Interdisciplinary Capstone Dinner and Expo at Sinclair Community College, the survey questions are directly related to the engineering technology outcomes as well as the discipline specific program outcomes for accreditation with ETAC/ABET. Those outcomes in survey form are as follows:

Engineering Technology Outcomes that apply to all Built Environment Programs:

1) Students have an ability to apply knowledge, techniques, skills and modern tools of mathematics, science, engineering, and technology to solve well-defined engineering problems appropriate to the discipline

2) Students have the ability to design solutions for well-defined technical problems and assist with the engineering design of systems, components, or processes appropriate to the discipline

3) Students can apply written, oral, and graphical communication in well-defined technical and non-technical environments; and an ability to identify and use appropriate technical literature

4) Students can conduct standard tests, measurements, and experiments and to analyze and interpret the results

5) Students are able to function effectively as a member of a technical team

In addition, program specific outcomes for **Architectural Technology** include:

e) Students can employ concepts of architectural theory and design in a design environment

f) Students are able to utilize instruments, methods, software, and techniques that are appropriate to produce A/E documents and presentations

g) Students can apply measuring methods that are appropriate for field, office, or laboratory

h) Students have the ability to apply fundamental computational methods and elementary analytical techniques in sub-disciplines related to architectural engineering.

Program specific outcomes for **Civil Engineering Technology** are:

a) Students can utilize the principles, hardware, and software that are appropriate to produce drawings, reports, quantity estimates, and other documents related to civil engineering

b) Students can perform standardized field and laboratory tests related to civil engineering

c) Students can utilize surveying methods appropriate for land measurement and/or construction layout

d) Students can apply fundamental computational methods and elementary analytical techniques in sub-disciplines related to civil engineering.

Program specific outcomes for **Construction Management Technology** are:

a) Students can utilize of techniques that are appropriate to administer and evaluate construction contracts, documents, and codes

b) Students can develop estimation of costs, estimation of quantities, and evaluation of materials for construction projects

c) Students are able to utilize measuring methods, hardware, and software that are appropriate for field, laboratory, and office processes related to construction

d) Students can apply fundamental computational methods and elementary analytical techniques in sub-disciplines related to construction engineering.

Responses by advisory board members to these questions are then analyzed by faculty to identify ways to improve both the specific discipline program as well as the interdisciplinary capstone course. It should be noted that even slight modifications or changes to prerequisite courses inspired by feedback from these surveys can have a direct impact on the success of

capstone students. Results of select advisory board assessments are located in Chapter 3 of this dissertation.

Faculty Feedback

Many opportunities for continuous improvement of the interdisciplinary capstone course will come from faculty. Spending time during the weekly faculty meetings while the course is underway will often yield ideas for improvement for the current course as well as for future course offerings.

In addition, it is important to have a debrief meeting with faculty after the course has ended to frankly discuss both what worked well and what improvements need to be made to anything relating to the interdisciplinary capstone course. It is also a good time to review ideas for improvement from the weekly faculty meetings.

During the course, a considerable amount of faculty time and effort will be ensuring that students are successfully meeting course outcomes. However, faculty should also enjoy the interdisciplinary capstone experience. Often, small tweaks and changes can greatly enhance faculty satisfaction and commitment.

Accreditation

Most accrediting agencies require review of student work (referred to as student artifacts by ETAC/ABET) to show how students are meeting program outcomes. Collecting interdisciplinary capstone student work is often a great way to show both the institution and accreditors student mastery towards those outcomes.

A repository of student work organized on an internal shared drive or through a Learning Management System will allow faculty to quickly search for examples of student work and analyze trend data over multiple terms.

CHAPTER 5: CONCLUSION

INTRODUCTION

The overarching goal of the interdisciplinary education guide in Chapter 4 is to solve complex problems with multiple disciplines in order to help simulate real-world collaboration that takes place within built environment professions. As noted by Palmer (2001), complex issues "rarely arise within orderly disciplinary categories, and neither do their solutions" (p. vii). Having students from different disciplines work together to solve a design challenge will create a better overall product and better prepare students for industry.

Built environment student teams representing the disciplines of Architecture Technology, Civil Engineering Technology, and Construction Management Technology can use their respective training to develop more feasible solutions than they would normally achieve working alone in silos and allows students to see the interdependencies among disciplines (Ashby & Exter, 2018). In addition, interdisciplinary education allows students to develop ways of thinking that "produce a cognitive advancement" that would not have been likely through only a single discipline (Biox-Mansilla & Duraising, 2007, p. 219). This chapter restates the purpose of the interdisciplinary guide found in Chapter 4 of this dissertation as well as recommended ways to implement the guide, limitations and assumptions, and suggestions for additional course enhancements and future research.

RESTATEMENT OF THE GOAL OF THE GUIDE

The interdisciplinary capstone guide is a "how to" manual for institutions and departments wishing to develop and run an interdisciplinary capstone course. Based on the best

practices, procedures, challenges, and successes of Sinclair Community College's Built Environment Department, the guide instructs faculty how to simulate the real-world experience of working across disciplines through an interdisciplinary capstone course within built environment degree programs.

While the guide is specific to two-year architecture, civil engineering, and construction management technology programs, it can easily be modified and tailored to serve other disciplines, including four-year programs, that wish to combine disciplines to work on either a simulated design project or with a community partner. Institutions are highly encouraged to customize the guide to fit the needs of the organization and community in which they serve.

RECOMMENDATIONS FOR IMPLEMENTING THE GUIDE

Successful implementation of an interdisciplinary capstone course will be more fully realized through proper and careful planning. Much of the work for faculty will occur well in advance of actually running the course. Tasks such as developing robust but achievable projects, establishing strong community partnerships, and balanced team assignments should take place months before students enter the classroom. The first part of the guide, "Developing an Interdisciplinary Capstone Course" offers the steps and framework for faculty who wish to build their own interdisciplinary course.

At institutions where little to no interdisciplinary work has occurred, faculty interested in offering an interdisciplinary capstone course may need to first work on getting department approval and institutional support. In addition, the outcomes of any variation of the course should be in harmony with the outcomes of each respective discipline and should also support accreditation requirements.

LIMITATIONS AND ASSUMPTIONS OF THE RESEARCH AND GUIDE

The interdisciplinary guide in Chapter 4 is based solely on the Built Environment Department's interdisciplinary capstone course at Sinclair Community College. Even though the course has been developed and refined after hundreds of hours of teaching in an interdisciplinary format, continual adjustments and improvements are made every year. The guide is a snapshot in time. The faculty at Sinclair will continue to make improvements and modifications to the course in order to meet the current needs of industry and the community.

The guide is based on two-year associate degree programs, at times including collaboration with university partners. While many of the projects and community partnerships will be nearly identical for both two-year and four-year programs, universities and/or academic departments may have additional program, capstone, intellectual property, or collaborative conditions. All interdisciplinary courses will need to address these requirements.

The guide assumes that there will be a sufficient number of students on each team. At a minimum, teams should be comprised of at least three students who represent no less than two different disciplines. Teams with more than five or six students typically give fewer opportunities for students to showcase their knowledge and skillsets unless each student on the team represents a different discipline.

The guide also assumes that enough interdisciplinary faculty will be assigned to the course. It is highly recommended that at least one faculty member is assigned to each team. Depending on complexity of the student projects, faculty can generally guide one or two interdisciplinary teams successfully. Overseeing more than two teams is generally not advisable.

Faculty in the Built Environment Department at Sinclair Community College have been fortunate to receive administrative approval and autonomy in offering the interdisciplinary

capstone course. Institutional support is critical. Good administrators will understand that the course may be a bit unrefined for the first couple of offerings, but with disciplined continual improvement efforts, can become the flagship model for meeting student readiness to enter industry.

Working with community partners can be a powerful method in helping students develop their skill sets during an interdisciplinary capstone course. To be most effective, community partners should be flexible when working with students, but have a general idea of basic design requirements and budget. Partners that are unable to commit to decisions during the term will stagnate the interdisciplinary team's progress. While building a relationship with the community partner, faculty should clearly define expectations and emphasize that the focus of the course is to help introduce students to the concept of solving problems as an interdisciplinary team.

Finally, the guide has limited discipline involvement outside of the built environment programs of Architectural Technology, Civil Engineering Technology, And Construction Management Technology. During some terms, students in Heating, Ventilation, Air Conditioning and Refrigeration as well as Energy Management Technology, Environmental Engineering Technology, and Interior Design have participated. Inviting faculty and students from other departments to participate often requires as much preparation as working with a university partner and can takes months to plan.

SUGGESTIONS FOR FUTURE COURSE ENHANCEMENTS AND RESEARCH

The interdisciplinary capstone guide in Chapter 4 can be used as a springboard model for additional research opportunities and interdisciplinary course enhancements. In addition to customization for disciplines, departments, and institutions, there are numerous opportunities in

researching various delivery models, involvement of disciplines outside of built environment, partnership development, and student success rates after graduation.

One such future research topic is the effectiveness and feasibility of adding additional disciplines outside of two-year built environment programs (defined in this dissertation as Architectural Technology, Civil Engineering Technology, and Construction Management Technology). For example, programs such as Unmanned Aerial Systems could combine with Geographic Information Systems and collaborate with local emergency services to map response areas or location of fire hydrants. Retail Business Management could combine with Marketing and Media programs to help a local entrepreneur or struggling business owner. The possibilities are endless.

In addition, there are numerous disciplines that could easily fit into the built environment interdisciplinary capstone either as team members or as clients. Students in programs similar to built environment such as energy analysis, real estate, structural engineering, geology, facilities management, or sustainability could be utilized on interdisciplinary teams and enhance the product deliverables. Even programs housed outside of a built environment department such as real estate, marketing, or video production could help support a community partner in an interdisciplinary format.

One research topic possibility is the effectiveness of the guide for four-year programs, including what modifications need to be made in order to effectively implement interdisciplinary capstone coursework at the baccalaureate level. What does the course look like when the roles of the guide in Chapter 4 are reversed and the university is the host, and a two-year school is invited to participate?

An area that has not been studied for this dissertation is the long-term impact of the course on students after graduation. For graduates that have gone on to a university, do they perform at higher levels or do better in coursework and group assignments? In industry, do graduates work across disciplines more easily than those that have not had interdisciplinary coursework? Are community partners more likely to use and implement suggestions from interdisciplinary teams over projects generated by a single discipline?

CHAPTER SUMMARY

This dissertation provides a practical "how to" guide for faculty considering interdisciplinary education in built environment programs. It provides faculty and departments a comprehensive blueprint for developing, delivering, and assessing a capstone course that will help students from multiple programs develop better solutions to a design challenge than would otherwise be realized with just a single discipline. The framework also employs the use of industry professionals, advisory board members, and community partners to help simulates real-world collaborations that help prepare students for success upon graduation.

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APPENDIX A: INSTITUTIONAL REVIEW BOARD APPROVAL LETTERS

FERRIS STATE UNIVERSITY
INSTITUTIONAL REVIEW BOARD FOR HUMAN SUBJECT RESEARCH
1010 Campus Drive FLITE 410 Big Rapids, MI 49307 | (231) 591-2553 | www.ferris.edu/irb

Date: November 23, 2020

To: Susan DeCamillis, EdD , Eric Dunn
From: Gregory Wellman, R.Ph, Ph.D, IRB Chair
Re: IRB Application *IRB-FY20-21-66 A Guide to Developing, Delivering, and Assessing an Interdisciplinary Capstone Course for Two-Year Built Environment Programs Based on the Best Practices of the Built Environment Department at Sinclair Community College.*

The Ferris State University Institutional Review Board (IRB) has reviewed your application for using human subjects in the study, *A Guide to Developing, Delivering, and Assessing an Interdisciplinary Capstone Course for Two-Year Built Environment Programs Based on the Best Practices of the Built Environment Department at Sinclair Community College (IRB-FY20-21-66)* and approved this project under Federal Regulations Exempt Category 1. Research, conducted in established or commonly accepted educational settings, that specifically involves normal educational practices that are not likely to adversely impact students' opportunity to learn required educational content or the assessment of educators who provide instruction. This includes most research on regular and special education instructional strategies, and research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.

Your protocol has been assigned project number IRB-FY20-21-66. Approval mandates that you follow all University policy and procedures, in addition to applicable governmental regulations. Approval applies only to the activities described in the protocol submission; should revisions need to be made, all materials must be approved by the IRB prior to initiation. In addition, the IRB must be made aware of any serious and unexpected and/or unanticipated adverse events as well as complaints and non-compliance issues.

This project has been granted a waiver of consent documentation; signatures of participants need not be collected.

As mandated by Title 45 Code of Federal Regulations, Part 46 (45 CFR 46) the IRB requires submission of annual status reports during the life of the research project and a Final Report Form upon study completion. Thank you for your compliance with these guidelines and best wishes for a successful research endeavor. Please let us know if the IRB can be of any future assistance.

Regards,

Gregory Wellman, R.Ph, Ph.D, IRB Chair
Ferris State University Institutional Review Board

SINCLAIR
COMMUNITY COLLEGE
Research, Analytics & Reporting

October 27, 2020

Eric Dunn
Professor
Civil Architectural Technology Department
Sinclair Community College

RE: Built Environment Programs Guide

Dear Professor Dunn:

As chair of the Sinclair Institutional Review Board for the Protection of Human Subjects (IRBOOO05624), I am writing to inform you that I have reviewed your proposal and approved the protocol as it meets the criteria for exempt status as established by the U.S. Department of Health and Human Services under category four. Please note that exempt proposals need not be reviewed by the full IRB (see Section 101, subsection b.1). Your planned research is fully compliant with Sinclair protocols.

Any serious adverse events or issues relating from this study must be reported immediately to the IRB. Additionally, any changes to protocols or informed consent documents must have IRB approval before implementation.

If you have any questions or concerns, please feel free to contact me. Good luck with your research.

Sincerely,

Chad Atkinson, Ph.D.
Manager of Research
Sinclair Community College, Research, Analytics, and Reporting
Chair, Sinclair Institutional Review Board
Phone: 937-512-4118
chad.atkinson4026@sinclair.edu

APPENDIX B: INTERDISCIPLINARY CAPSTONE COURSE CHECKLIST

Development (3 – 12 months prior to the start of term)

- Advisory Board
  - Advisory Board Update Regarding Interdisciplinary Planning
  - Seek Volunteers for Midterm 2
- Community Partners
  - Complete Service Learning Paperwork
  - Sign Legal Documents
  - Tour Project Site
- Dinner and Expo
  - Reserve Venue
- Faculty
  - Define Interdisciplinary Faculty
  - Define Faculty Lead for Interdisciplinary Projects
  - Develop Project Poster Boards
- Interdisciplinary Projects
  - Community partner
  - Deliverables
  - Description
  - Disciplines
  - Faculty advisors
  - Location
  - Outcomes
- Logo
  - Finalize Logo and Color

- Software / Computers
  - Install New Software
  - Install Updates
  - Upgrade Computers
- University Partners
  - Determine Level of Involvement (Consultants or Fully Involved)
  - Define Roles

Development (1 – 3 months prior to the start of term)

- Administrative
  - Check Functionality Of Equipment
  - Order Supplies
  - Schedule Day to Day Workrooms
  - Schedule Kickoff Meeting Room
  - Schedule Midterm Room
- Advisory Board Members
  - Invite Select Advisory Board Members to Midterm 2 Review
- Classrooms and Labs
- Faculty
  - Approve Students to Take Interdisciplinary Capstone Course
    - Ensure Prior Coursework Completed
    - Review of Student Evaluations
  - Department Registers Students in Course
  - Organize Student Teams
  - Record Student Apparel Sizes
- Learning Management System
  - Load Reference Files
  - Organize Student Teams
  - Post Syllabus and Calendar
  - Set Up Attendance

- Schedule Drop Boxes
- Supporting Course Documents
  - Finalize Assignment and Rubrics
  - Finalize Schedule

During the Term

- Administrative
  - Group Photograph
  - Order Apparel
- Boot Camps
  - Poster Board Development
  - Resume Writing
- Dinner and Expo
  - Develop Agenda
  - Develop Seating Chart
  - Invite Speakers
  - Print Name Badges
  - Send Out Invitations
  - Develop and Print QR (Quick Read) Codes
- Exit Interviews
  - Order Refreshments
  - Schedule Each Discipline
  - Send Students Questions Prior to Meeting
- Kickoff Meeting
  - Divide into Teams
  - Introduce Interdisciplinary Concept
  - Review Assignments and Rubrics
  - Sign Community Partner Agreement
  - Sign Service Learning Agreements

- Midterm 2 Review
    - Advisory Board Reminders
    - Define Expectations with Board Members
    - Order Refreshments
- Underwriting
    - Send Out Ask Letters
        - Advisory Board Members
        - Alumni
        - Local Built Environment Firms
        - Organizations and Companies That Offer Student Internships
        - Retired Built Environment Faculty
        - Supporters of The Programs

After the Term Ends

- Administrative
    - Update Assignments and Rubrics
    - Update Learning Management System
- Faculty
    - Celebrate!
    - Debrief Term
        - Advisory Board Participation
        - Assignments and Rubrics
        - Boot Camps
        - Classrooms / Labs
        - Day and Time
        - Deliverables
        - Dinner and Expo
        - Kickoff Meeting
        - Learning Management System

- Needed Improvements
- Community Partnerships / Service Learning
- Outside Departments
- Projects
- Review Surveys
    - Advisory Board Feedback
    - End of Course Surveys
    - Exit Interviews
- Survey Instruments
- Software and Equipment
- University Partnerships
- What Did Not Go Well, Why
- What Went Well, Why

- Student Work
    - Archive
    - Organize for Accreditation

APPENDIX C: EXAMPLE OF PROJECT POSTER BOARD

PROJECT THREE

Dayton Visual Arts Center
Dayton, Ohio

ENGINEERING TECHNOLOGY DESIGN CAPSTONE 2018

Schematic Design

Design Development

Construction Documents

Project Three—
Dayton Visual Arts Center Renovation and Relocation

The Dayton Visual Arts Center (DVAC) needs additional space to accommodate expanded gallery and educational operations. The organization is considering three options:

- Current location—expand to occupy additional first floor space, renovate existing
- New location—Arcade center location in cooperation with developers
- New location—New building to accommodate DVAC and two aligned organizations

The Program

The DVAC facility will include:

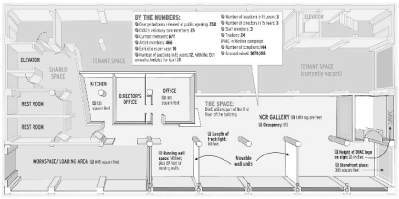
- Gallery Space 1
- Gallery Space 2
- Curatorial/Education Space
- Storage
- Kitchen/Break Room
- Office—Operations
- Office—Director
- Coat Room
- Restrooms

The Site

DVAC is in need of three design options, each at a unique site as indicated on the map below.

The Client

The Dayton Visual Arts Center was founded in 1991 by a coalition of Dayton-area artists, art supporters, and visual arts professionals who saw a need for more interaction between the public and regional artists. DVAC's founders established an organization that allows the community to see and experience the wealth and diversity of visual art being created in the area and to get to know these artists. Over the years, DVAC has presented a schedule of exhibitions that has explored the variety and diversity of the visual arts in communities from Dayton, Ohio and internationally.



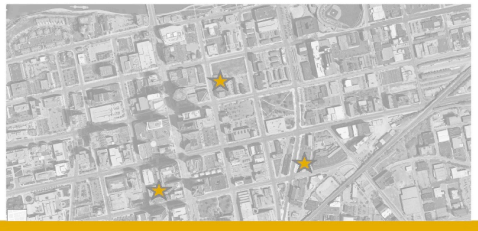
The Dayton Visual Arts Center is a group of artists and art lovers who believe that a vital visuals arts community is essential to the life of the community. From gallery talks and exhibit openings to professional development workshops, DVAC provides opportunities to meet others who share an interest in art and to learn about and support contemporary visual art. Since 1991, DVAC has been a leading proponent of contemporary art in the region. Our gallery in downtown Dayton presents a full schedule of innovative exhibitions each year. The annual art auction has grown to become one of the largest auctions of contemporary art in Ohio. ARTtoBUY, which includes the very popular holiday gift gallery, connects artists with the public for the purchase of reasonably priced fine art and fine craft. Through Art Source, we consult with art collectors, assisting them in finding art by regional artists. And we have fun together, presenting a series of Artist Palate parties in the homes and studios of artists and art collectors.

The Dayton Visual Arts Center (DVAC) is a resource for everyone who enjoys art. It's a place where artists and art collectors find each other. Our gallery on North Jefferson Street, between First and Second streets in downtown Dayton, features rotating exhibits of professionally hung contemporary art. You will always find something new at DVAC. While you're visiting, ask about upcoming events and programs.

DVAC mounts 12 to 18 exhibits each year, showing art that is being made here and now, expressing ideas about our environment and society. A 501 (c) (3) nonprofit organization that encourages working artists, DVAC provides educational programs and activities for anyone who has an interest in the visual arts, whether they create it or not.

The Deliverables

- Design images and supporting documents for DVAC marketing efforts
- Complete set of working drawings (civil and architectural)
- Project schedule
- Construction estimate
- Three phase job site layout



20 An Integrated Project Delivery Capstone 18

Engineering Technology Design Department
Sinclair Community College
Dayton, Ohio

APPENDIX D: COMMONLY USED CAPSTONE PROJECT SUPPLIES

- 3D printers and filament
- Binders
- Binding machines
- Code books
- Current software with updates
- Digital camera
- Foam core board
- Hole punch
- Knives
- Legal agreements
- Markers, pens, and pencils
- Photocopier and scanner
- Plotter and plotter paper
- Poster boards
- References
- Spray adhesive
- Stapler
- Tape
- Tracing paper
- Virtual Reality (VR) equipment

APPENDIX E: ASSIGNMENT AND GRADING RUBRIC

CAPSTONE 2020

ASSIGNMENTS AND GRADING RUBRICS

WEEKLY TIME AND ACTIVITY REPORTS (T-1 THROUGH T-16)

Requirements: The weekly report is a one-page document completed by each student that indicates hours worked during the week, anticipated tasks for the next week and a brief reflection on the capstone experience. The form must be downloaded from the eLearn Community Shell and updated throughout the semester. The week runs Monday through Sunday.

Due: At the beginning of each class on Monday at the start of class (5:30 PM).

Submission: The weekly report is due at the beginning of class each Monday and shall be submitted via the drop box in the Built Environment Capstone 2020 eLearn Community in *.xlsx format.

Point Value: 5 points each, 8% of overall grade (Individual).

Grade Assigned by: Faculty Advisor for Team

Grading Rubric: See eLearn for more complete metrics based upon the following elements:

- Completeness
- Accuracy
- Professionalism

5 Points	Report filled out completely, proper spelling, punctuation, legible writing, accurate and honest representation of hours, thoughtful reflection. In attendance both days previous week. Time recorded is accurate and honest.
4 Points	Report filled out but with a few missing pieces of data or grammatical errors. Reflection thoughtful but lacks detail. In attendance both days previous week. Time recorded is mostly correct.
3 Points	Report submitted with multiple pieces of data missing. Report does not conform to the template provided through eLearn. Grammatical errors and lack of thoughtful reflection. Missed one day previous week. Time recorded contains errors.
1-2 Points	Incompletely filled out, poor grammar, illegible writing, dishonest representation of hours. Missed one or more days. Time recorded is inaccurate. Report does not conform to the template provided through eLearn.
0 Points	Failure to turn in or turn in late without prior approval from faculty advisor. Missed both days previous week. Time recorded is dishonest.

CAPSTONE 2020

ASSIGNMENTS AND GRADING RUBRICS

WEEKLY TEAM PROGRESS MEETINGS (M-1 THROUGH M-13)

Requirements: Attend a weekly team meeting with your faculty advisor and/or consultants based upon a meeting agenda prepared prior to class period. Review and approve minutes from previous meeting(s), take notes, make specific assignments, ask questions, consult disciplines and coordinate efforts as a team.

Due: At the beginning of each class on Monday or as specified in the semester schedule. The agenda will be based on your work the previous week, but will also include assigned action items, goals, needs and concerns for the upcoming work week.

Submission: The weekly team progress meeting will be approximately 30 minutes every week.

Point Value: 5 points each, 6.5% of overall grade (Team).

Grade Assigned by: Faculty Advisor for Team

Grading Rubric: See eLearn for more complete metrics based upon the following elements identified within the Degree Program Outcomes:

- Problem-Solving
- Project Deliverables
- Teamwork
- Communication
- Professionalism

5 Points	Team members attend weekly team meeting, all members participates in discussion and work collaboratively with other team members. Meeting minutes reviewed and approved from previous week. Notes taken and specific assignments made. Student chairs meeting from prepared agenda.
4 Points	Team members attend weekly team meeting, limited participation by members in team discussion and generally work collaboratively most of the time with other team members. Minutes reviewed and approved from previous week. Students chairs meeting from prepared agenda.
3 Points	Some members attend team meeting reluctantly or arrive late, little participation in team discussion, more doodles than notes, poor cooperation amongst team members or with other disciplines. Student reluctantly chairs meeting without prepared agenda or previous meeting minutes.
1-2 Points	Team members arrive late to team meeting, no participation in team meeting, no note taking, little to no cooperation amongst team members. Faculty member chairs meeting, missing agenda and previous meeting minutes.
0 Points	Team does not hold meeting or team members are generally antagonistic toward each other.

CAPSTONE 2020

ASSIGNMENTS AND GRADING RUBRICS

RESUME – MARKED COPY (R-1)

Requirements:	Develop a professional resume worthy of submission to an employer.	
Due:	Wednesday, March 25, 2020 resume mark up.	
Submission:	Marked up copy is a one-page paper submission showing all written revisions by the Student and Community Engagement office located in the basement of Building 8. The resume will be due at 5:30 PM and shall be submitted via the drop box in the Built Environment Capstone 2020 eLearn Community. Faculty advisors will be receiving periodic updates on student progress.	
Point Value:	20 points, 2% of overall grade (Individual).	
Grade Assigned by:	Faculty Advisor by Discipline	
Grading Rubric:	20 Points	Resumes completed and marked up by career services.
Mark Up:	0 Points	Failure to turn in or turn in late without prior approval from faculty advisor.

CAPSTONE 2020

ASSIGNMENTS AND GRADING RUBRICS

RESUME – FINAL/PDF (R-2)

Requirements: Develop a professional resume worthy of submission to an employer.

Due: Wednesday, April 8, 2020 (via JobLink)

Submission: Submit a final copy to Sinclair's JobLink and through via the drop box as a PDF file in the Built Environment Capstone 2020 eLearn Community. For more information, see a team member at the Student and Community Engagement office in the basement of Building 8. Faculty advisors will be receiving periodic updates on student progress.

Point Value: 30 points, 3% of overall grade (Individual).

Grade Assigned by: Faculty Advisor by Team

Grading Rubric:

28-35 Points	Resumes complete with all marked up errors corrected. Professional layout, legible. PDF copy submitted via the drop box in eLearn. File correctly named.
19-27 Points	Resume mostly complete with a few small errors or omissions. File correctly named.
10-18 Points	Resume missing some data, not all red stamp errors corrected. PDF not named properly.
1-9 Points	Significant amounts of data missing, few red stamped errors corrected, major grammatical errors. No PDF submitted.
0 Points	Failure to turn in or turn in late without prior approval from faculty advisor.

CAPSTONE 2020

ASSIGNMENTS AND GRADING RUBRICS

DOCUMENTATION – PROJECT DELIVERABLES (D-1)

Requirements: Develop a comprehensive list of project deliverables that documents and organizes all of the work to be generated during the semester. The list shall reflect elements identified through two (2) brainstorming sessions; one discipline specific [e.g. Architectural, Construction Management, Civil Engineering and Environmental (as appropriate)] and one team specific.

Due: Wednesday, January 8, 2020 at the end of class (9:10 PM).

Submission: The list of deliverables will be due at the end of class and shall be submitted via the drop box in the Built Environment Capstone 2020 eLearn Community.

Point Value: 15 points, 1.5% of overall grade (Team).

Grade Assigned by: Aggregate of Faculty Advisor scores

Grading Rubric:

12-15 Points	List of deliverables logically organized, all required elements identified, all team disciplines represented, spelling and grammar correct.
8-11 Points	List of deliverables organized, most required elements identified, majority of team disciplines represented, some spelling and grammatical mistakes.
4-7 Points	List of deliverables poorly organized, some of the required elements identified, team disciplines not fully represented, significant spelling and grammatical mistakes.
1-3 Points	List of deliverables dysfunctional, less than half of the required elements identified, team disciplines missing, significant spelling and grammatical mistakes.
0 Points	Failure to turn in or turn in late without prior approval from faculty advisor.

CAPSTONE 2020

ASSIGNMENTS AND GRADING RUBRICS

MIDTERM DELIVERABLE 1 – FACULTY (D-2)

Requirements: Deliver a hard copy review of work to date to faculty advisors. Plans and project documents should reflect 25% completion.

Due: Monday, January 27, 2020. Hard copy documents due at 5:30 PM to the corresponding faculty advisor by discipline (e.g. architectural plans to Professor X, construction schedule to Professor Y, civil plans to Professor Z); no late submittals accepted.

Submission: Compile a concise set of project documents (e.g. conceptual drawings, site plan, construction schedule, research materials) that demonstrates all work to date, major decisions made and a course of action taken based upon discipline assignments.

Point Value: 30 points, 3% of overall grade (Individual).

Grade Assigned by: Faculty Advisor by Discipline

Grading Rubric:

24-30 Points	Work represented is delivered in a clear and concise format that shows all work completed to date. Project documents are easy to read and understand. No spelling or grammatical errors.
16-23 Points	Work represented is fairly clear and concise and shows nearly all work to date. Most information on the project documents can be easily understood. A few spelling and grammatical errors.
8-15 Points	Work represented is not easily understood and shows little work to date. Project documents are hard to read with spelling and grammatical errors.
1-7 Points	Project documents represented are confusing and hard to understand. Significant spelling and grammatical errors.
0 Points	Failure to deliver.

CAPSTONE 2020

ASSIGNMENTS AND GRADING RUBRICS

MIDTERM DELIVERABLE 2 – FACULTY (D-3)

Requirements: Deliver a hard copy review of work to date to faculty advisors. Plans and project documents should reflect 50% completion.

Due: Monday, February 17, 2020. Hard copy documents due at 5:30 PM to the corresponding faculty advisor by discipline (e.g. architectural plans to Professor X, construction schedule to Professor Y, civil plans to Professor Z); no late submittals accepted.

Submission: Compile a concise set of project documents (e.g. conceptual drawings, site plan, construction schedule, research materials) that demonstrates all work to date, major decisions made and course of action taken based upon discipline assignments.

Point Value: 35 points, 3.5% of overall grade (Individual).

Grade Assigned by: Faculty Advisor by Discipline

Grading Rubric:

28-35 Points	Work represented is delivered in a clear and concise format that shows all work completed to date. Project documents are ~~is~~ easy to read and understand with all revisions completed from previous faculty review. No spelling or grammatical errors.
19-27 Points	Work represented is fairly clear and concise and shows nearly all work to date. Most information on the project documents can be easily understood with all revisions completed from previous faculty review. A few spelling and grammatical errors.
9-18 Points	Work represented is not easily understood and shows little work to date. Project documents are hard to read with spelling and grammatical errors with most revisions completed from previous faculty review.
1-8 Points	Project documents represented are confusing and hard to understand with some revisions completed from previous faculty review. Significant spelling and grammatical errors.
0 Points	Failure to deliver.

CAPSTONE 2020

ASSIGNMENTS AND GRADING RUBRICS

MIDTERM DELIVERABLE 3 – FACULTY (D-4)

Requirements:	Deliver a hard copy review of work to date to faculty advisors. Plans and project documents should reflect 75% completion.	
Due:	Monday, March 23, 2020. Hard copy documents due at 5:30 PM to the corresponding faculty advisor by discipline (e.g. architectural plans to Professor X, construction schedule to Professor Y, civil plans to Professor Z); no late submittals accepted.	
Submission:	Compile a concise set of project documents (e.g. conceptual drawings, site plan, construction schedule, research materials) that demonstrates all work to date, major decisions made and a course of action taken based upon discipline assignments.	
Point Value:	50 points, 5% of overall grade (Individual).	
Grade Assigned by:	Faculty Advisor by Discipline	
Grading Rubric:	41-50 Points	Work represented is delivered in a clear and concise format that shows all work completed to date. Project documents are easy to read and understand with all revisions completed from previous faculty review. No spelling or grammatical errors.
	28-40 Points	Work represented is fairly clear and concise and shows nearly all work to date. Most information on the project documents can be easily understood with all revisions completed from previous faculty review. A few spelling and grammatical errors.
	15-27 Points	Work represented is not easily understood and shows little work to date. Project documents are hard to read with spelling and grammatical errors with most revisions completed from previous faculty review.
	1-14 Points	Project documents represented are confusing and hard to understand with some revisions completed from previous faculty review. Significant spelling and grammatical errors.
	0 Points	Failure to deliver.

CAPSTONE 2020

ASSIGNMENTS AND GRADING RUBRICS

DOCUMENTATION – JOURNAL/PLANS 1 (J-1)

Requirements: Develop a professional team journal that documents and organizes all of the work generated during the semester to date.

The journal shall include a table of contents and the following tabs: Team Members, Project Requirements, Team Meetings, References, Architectural, Construction Management, Civil Engineering, Energy, and Environmental disciplines (as appropriate).

Due: Wednesday, February 12, 2020 at the beginning of class (5:30 PM).

Submission: A single team journal that includes all work to date.

Point Value: 30 points total, 15 individual/15 team, 3% of overall grade.

Grade Assigned by: Individual: Faculty Advisor by Discipline
Team: Faculty Advisor by Team

Grading Rubric:

24-30 Points	Journal logically organized, all work captured, all team disciplines represented, spelling and grammar correct.
16-23 Points	Journal organized, most work captured, majority of team disciplines represented, some spelling and grammatical mistakes.
8-15 Points	Journal poorly organized, little work captured, team disciplines not fully represented, significant spelling and grammatical mistakes.
1-7 Points	Journal dysfunctional, little to no work captured, team disciplines missing, significant spelling and grammatical mistakes.
0 Points	Failure to turn in or turn in late without prior approval from faculty advisor.

CAPSTONE 2020

ASSIGNMENTS AND GRADING RUBRICS

DOCUMENTATION – JOURNAL/PLANS 2 (J-2)

Requirements: Develop a professional team journal that documents and organizes all of the work generated during the semester to date.

Include a table of contents and the following tabs: Team Members, Project Requirements, Team Meetings, References, Architectural, Construction Management, Civil Engineering, Energy, and Environmental (as appropriate).

All marks deducted from the previous journal review shall be corrected.

Due: Wednesday, March 18, 2020 at the beginning of class (5:30 PM).

Submission: A single team journal that includes all work to date.

Point Value: 30 points total, 15 individual/15 team, 3% of overall grade.

Grade Assigned by: Individual: Faculty Advisor by Discipline
Team: Faculty Advisor by Team

Grading Rubric:

24-30 Points	Journal logically organized, all work captured, all team disciplines represented, spelling and grammar correct. All marks from previous review corrected.
16-23 Points	Journal organized, most work captured, majority of team disciplines represented, some spelling and grammatical mistakes. Most of the marks from previous review corrected.
8-15 Points	Journal poorly organized, little work captured, team disciplines not fully represented, significant spelling and grammatical mistakes. A few of the marks from previous review corrected.
1-7 Points	Journal dysfunctional, little to no work captured, team disciplines missing, significant spelling and grammatical mistakes. No marks from previous review corrected.
0 Points	Failure to turn in or turn in late without prior approval from faculty advisor.

CAPSTONE 2020

ASSIGNMENTS AND GRADING RUBRICS

DOCUMENTATION – JOURNAL/PLANS 3 (J-3)

Requirements: Develop a professional team journal that documents and organizes all of the work generated during the semester to date.

Include a table of contents and the following tabs: Team Members, Project Requirements, Team Meetings, References, Architectural, Construction Management, Civil Engineering, Energy, and Environmental.

All marks deducted from the previous journal review shall be corrected.

Due: Wednesday, April 15, 2020 at the beginning of class (5:30 PM).

Submission: A single team journal that includes all work to date.

Point Value: 50 points total, 25 individual/25 team, 5% of overall grade.

Grade Assigned by: Individual: Faculty Advisor by Discipline
Team: Faculty Advisor by Team

Grading Rubric:

41-50 Points	Journal logically organized, all work captured, all team disciplines represented, spelling and grammar correct. All marks from previous review corrected.
28-40 Points	Journal organized, most work captured, majority of team disciplines represented, some spelling and grammatical mistakes. Most of the marks from previous review corrected.
15-27 Points	Journal poorly organized, little work captured, team disciplines not fully represented, significant spelling and grammatical mistakes. A few of the marks from previous review corrected.
1-14 Points	Journal dysfunctional, little to no work captured, team disciplines missing, significant spelling and grammatical mistakes. No marks from previous review corrected.
0 Points	Failure to turn in or turn in late without prior approval from faculty advisor.

CAPSTONE 2020

ASSIGNMENTS AND GRADING RUBRICS

DOCUMENTATION – JOURNAL/PLANS FINAL (J-4)

Requirements: Develop a professional team journal and set of prints that documents and organizes all of the work generated during the semester. This version should be trade show worthy.

Include a table of contents and the following tabs: Team Members, Project Requirements, Team Meetings, References, Architectural, Construction Management, Civil Engineering, Energy, and Environmental.

All marks deducted from previous journal reviews shall be corrected.

Due: Monday, April 27, 2020 at the end of the tradeshow.

Submission: A single team journal that includes all work to date.

Point Value: 80 points total, 40 individual/40 team, 8% of overall grade.

Grade Assigned by: Individual: Faculty Advisor by Discipline
Team: Faculty Advisor by Team

Grading Rubric:

65-80 Points	Journal logically organized, all work captured, all team disciplines represented, spelling and grammar correct. All marks from previous review corrected.
45-64 Points	Journal organized, most work captured, majority of team disciplines represented, some spelling and grammatical mistakes. Most of the marks from previous review corrected.
24-44 Points	Journal poorly organized, little work captured, team disciplines not fully represented, significant spelling and grammatical mistakes. A few of the marks from previous review corrected.
1-23 Points	Journal dysfunctional, little to no work captured, team disciplines missing, significant spelling and grammatical mistakes. No marks from previous review corrected.
0 Points	Failure to turn in or turn in late without prior approval from faculty advisor.

CAPSTONE 2020

ASSIGNMENTS AND GRADING RUBRICS

MIDTERM REVIEW 1 – FACULTY (P-1)

Requirements: Deliver a review of work to date (at least 25% complete) to faculty advisors and consultants. Each team will receive five minutes of presentation time per team member, plus ten minutes of questions and answers. Presentations will be in random order, to be drawn on the evening of the presentations.

Due: Wednesday, January 29, 2020. Poster board due at 4:00 PM to a faculty advisor; poster submittal times will be recorded and no late submittals accepted.

Submission: Develop a one page poster board (24" x 36", oriented portrait style) that highlights all work to date, including major decisions made, course of action, and discipline assignments. Be prepared to answer questions from faculty advisors and consultants.
The department will provide poster board, spray glue and a place to assemble your poster. It must be completely assembled when submitted. Poster boards are not to be cut, trimmed or altered from their original size.

Dress: Business Casual

Point Value: 30 points total, 15 individual/15 team; 3% of overall grade.

Grade Assigned by: Aggregate of Faculty Advisor scores

Grading Rubric:

	Individual	Team
12-15 Points	Delivers discipline specific contribution to team. Work is evident and well described. Questions answered in a professional manner. Appropriate business casual dress.	Project work represented is delivered in a clear and concise format that shows all work completed. No spelling or grammatical errors. All team members speak.
8-11 Points	Delivers discipline specific contribution to team. Work is mostly evident and well described. Most questions answered in a professional manner. Appropriate business casual dress.	Project work represented is fairly clear and concise and shows nearly all work completed. Most information can be easily understood. A few spelling and grammatical errors.
4-7 Points	Inadequately delivers any specific contribution to team. Questions not answered in a professional manner or left unanswered. Not dressed in business casual attire.	Project work represented is not easily understood and shows little completed. Spelling and grammatical errors.
1-3 Points	Does not deliver any specific contribution to team. Questions answered in a demeaning and hostile way. Not dressed in business casual attire.	Overall work represented is confusing and hard to understand. Significant spelling and grammatical errors.
0 Points	Failure to attend or participate.	Failure to deliver or deliver late without prior approval of faculty.

CAPSTONE 2020

ASSIGNMENTS AND GRADING RUBRICS

MIDTERM REVIEW 2 – ADVISORY BOARD (P-2)

Requirements: Deliver a review of work to date (at least 50% complete) to faculty advisors, consultants and advisory board members. Each team will receive five minutes of presentation time per team member, plus ten minutes of questions and answers. Presentations will be in random order, to be drawn on the evening of the presentations.

Due: Wednesday, February 19, 2020. Poster board due at 4:00 PM to a faculty advisor; poster submittal times will be recorded and no late submittals accepted.

Submission: Develop a one page poster board (24" x 36", oriented portrait style) that highlights all work to date, including major decisions made, course of action, and discipline assignments. Be prepared to answer questions from faculty advisors and consultants.
The department will provide poster board, spray glue and a place to assemble your poster. It must be completely assembled when submitted. Poster boards are not to be cut, trimmed or altered from their original size.

Dress: Business Formal

Point Value: 60 points total, 30 individual/30 team; 6% of overall grade.

Grade Assigned by: Aggregate of Faculty Advisor and Board Member scores

Grading Rubric:

	Individual	Team
24-30 Points	Delivers discipline specific contribution to team. Work is evident and well described. Questions answered in a professional manner. Appropriate business formal dress.	Project work represented is delivered in a clear and concise format that shows all work completed. No spelling or grammatical errors. All team members speak.
16-23 Points	Delivers discipline specific contribution to team. Work is mostly evident and well described. Most questions answered in a professional manner. Appropriate business formal dress.	Project work represented is fairly clear and concise and shows nearly all work completed. Most information can be easily understood. A few spelling and grammatical errors.
8-15 Points	Inadequately delivers any specific contribution to team. Questions not answered in a professional manner or left unanswered. Not dressed in business formal attire.	Project work represented is not easily understood and shows little completed. Spelling and grammatical errors.
1-7 Points	Does not deliver any specific contribution to team. Questions answered in a demeaning and hostile way. Not dressed in business formal attire.	Overall work represented is confusing and hard to understand. Significant spelling and grammatical errors.
0 Points	Failure to attend or participate.	Failure to deliver or deliver late without prior approval of faculty.

CAPSTONE 2020

ASSIGNMENTS AND GRADING RUBRICS

MIDTERM REVIEW 3 – FACULTY (P-3)

Requirements: Deliver a review of work to date (at least 75% complete) to faculty advisors and consultants. Each team will receive five minutes of presentation time per team member, plus ten minutes of questions and answers. Presentations will be in random order, to be drawn on the evening of the presentations.

Due: Wednesday, March 25, 2020. Poster board due at 4:00 PM to a faculty advisor; poster submittal times will be recorded and no late submittals accepted.

Submission: Develop a one page poster board (24" x 36", oriented portrait style) that highlights all work to date, including major decisions made, course of action, and discipline assignments. Be prepared to answer questions from faculty advisors and consultants.
The department will provide poster board, spray glue and a place to assemble your poster. It must be completely assembled when submitted. Poster boards are not to be cut, trimmed or altered from their original size.

Dress: Business Casual

Point Value: 100 points total, 50 individual/50 team; 10% of overall grade.

Grade Assigned by: Aggregate of Faculty Advisor scores

Grading Rubric:

	Individual	Team
41-50 Points	Delivers discipline specific contribution to team. Work is evident and well described. Questions answered in a professional manner. Appropriate business casual dress.	Project work represented is delivered in a clear and concise format that shows all work completed. No spelling or grammatical errors. All team members speak.
28-40 Points	Delivers discipline specific contribution to team. Work is mostly evident and well described. Most questions answered in a professional manner. Appropriate business casual dress.	Project work represented is fairly clear and concise and shows nearly all work completed. Most information can be easily understood. A few spelling and grammatical errors.
15-27 Points	Inadequately delivers any specific contribution to team. Questions not answered in a professional manner or left unanswered. Not dressed in business casual attire.	Project work represented is not easily understood and shows little completed. Spelling and grammatical errors.
1-14 Points	Does not deliver any specific contribution to team. Questions answered in a demeaning and hostile way. Not dressed in business casual attire.	Overall work represented is confusing and hard to understand. Significant spelling and grammatical errors.
0 Points	Failure to attend or participate.	Failure to deliver or deliver late without prior faculty approval.

CAPSTONE 2020

ASSIGNMENTS AND GRADING RUBRICS

MIDTERM REVIEW 4 – FACULTY/STUDENTS (P-4)

Requirements: Deliver a review of work to faculty advisors, consultants and capstone students.

Due: Monday, April 20, 2020 at 4:00PM.

Submission: Microsoft PowerPoint file via the drop box in the Built Environment Capstone 2020 eLearn Community. Deliver a 30-minute slideshow presentation that shows the team solution to the project challenge. Highlights all work, including major decisions made, course of action, and outcomes. Be prepared to answer questions from faculty advisors, consultants and fellow capstone students.

Dress: Business Casual

Point Value: 150 points total, 75 individual/75 team, 15% of overall grade.

Grading Rubric: Aggregate of Faculty Advisor scores

	Individual	Team
62-75 Points	Delivers discipline specific contribution to team. Work is evident and well described. Questions answered in a professional manner. Appropriate business casual dress.	Project work represented is delivered in a clear and concise format that shows all work completed. No spelling or grammatical errors. All team members speak.
42-61 Points	Delivers discipline specific contribution to team. Work is mostly evident and well described. Most questions answered in a professional manner. Mostly appropriate business casual dress.	Project work represented is fairly clear and concise and shows nearly all work completed. Most information can be easily understood. A few spelling and grammatical errors.
22-41 Points	Inadequately delivers any specific contribution to team. Questions not answered in a professional manner or left unanswered. Not dressed in business casual attire.	Project work represented is not easily understood and shows little completed. Spelling and grammatical errors.
1-21 Points	Does not deliver any specific contribution to team. Questions answered in a demeaning and hostile way. Not dressed business casual.	Overall work represented is confusing and hard to understand. Significant spelling and grammatical errors.
0 Points	Failure to attend or participate.	Failure to deliver or deliver late without prior approval of faculty.

CAPSTONE 2020

ASSIGNMENTS AND GRADING RUBRICS

FINAL PRESENTATION – DINNER AND EXPO (D-5)

Requirements: After dinner, deliver a review of work to faculty advisors, consultants, advisory board members, Sinclair faculty and administrators in a trade show format. Highlights should include all work, including major decisions made, course of action, and outcomes. Be prepared to answer questions from faculty advisors, consultants, advisory board members, and various administrators.

Due: Monday, April 27, 2020. Dinner begins at 5:30 PM with Expo to follow. Team setup begins approximately 1 hour prior to dinner with breakdown of display items commencing after all guests have departed. All materials and equipment must be returned to the proper location.

Submission: Submit copies of all documentation displayed at tradeshow, including electronic files uploaded to the drop box in the Built Environment Capstone 2020 eLearn Community.

Dress: Business Formal

Point Value: 150 points total, 75 individual/75 team, 15% of overall grade.

Grade Assigned by: Aggregate of Faculty Advisor scores

Grading Rubric:

124-150 Points	Work represented is delivered in a clear and concise format that shows all work completed. Team stays together at assigned location. No spelling or grammatical errors. Questions answered in a professional manner. Appropriate business formal dress. All team members speak to invitees.
84-123 Points	Work represented is fairly clear and concise and shows nearly all work completed. Most information can be easily understood. A few spelling and grammatical errors. Most questions answered in a professional manner. Some team members wander off or are unengaged. Most team members dressed appropriately. Most team members speak.
44-83 Points	Work represented is not easily understood and shows little work completed. Spelling and grammatical errors. Questions not answered in a professional manner or left unanswered. Team members unengaged and uninterested in presenting work. Most team members not dressed in business casual attire. Only few team members speak.
1-43 Points	Work represented is confusing and hard to understand. Significant spelling and grammatical errors. Questions answered in a demeaning and hostile way. Majority of team members leave assigned location. Public quarreling between team members. Team members not dressed business formal. Only one team member speaks.
0 Points	Failure to attend or act professionally.

APPENDIX F: WEEKLY TIME AND ACTIVITY REPORT

Capstone Weekly Time and Activity Report

Due before the beginning of class every Monday. Please submit electronically via the drop box in eLearn.

Name: _____ **Dates:** _____

Range is Monday through Sunday

Discipline: _____

Team: _____

Completed Tasks during reporting period

Category *Drop-down Menu*	**Details of the completed task** *Examples: "research regulatory requirements, REVIT/Civil 3D design, RS Means QTO"*	**Actual Time** *Duration of tasks completed (nearest 0.1 hour)*	**Estimated Vs. Actual** *Comparison of estimated durations from two weeks ago with actuals from previous week*

Total Hours for Week: _____

Planned Tasks for next reporting period

Category *Drop-down Menu*	**Details of the planned task** *Examples: "revise floor plan, meet with Ohio EPA, site preparation schedule"*	**Estimated Time** *Estimated duration of planned tasks (nearest 1 hour)*	**Resources** *List the resources you need in order to complete the planned task.*

Planned Hours for Upcoming Week: _____

Personal Reflection: *Thoughts about knowledge of your discipline, the project, the team, your role, lessons learned, etc.*
Overall Team Progress Rating Overall Individual Progress Rating

APPENDIX G: INTERDISCIPLINARY CAPSTONE MIDTERM GRADING RUBRIC

Capstone 2020

Integrated Project Design

Project name: _____

Score:		
	Potential team points:	75 (Enter on this side of sheet)
	Potential individual points:	75 (Enter on reverse side of sheet)
	Total potential points:	150 (15% of overall grade)

Circle team scores below:

Problem-solving Abilities (Weight = 20%)

Based upon the project scope, defines the design challenge; identifies solutions; evaluates options and provides justification for decision-making; implements the design solution. Progress should reflect a 99% deliverable.

Poor			Needs Improvement			Average		Exceptional	
1	2	3	4	5	6	7	8	9	10

Project Deliverables (Weight = 20%)

Project deliverables as assigned by faculty (construction documents, drawings, reports, schedules, etc.) are clear and concise and demonstrates a solid understanding of the project scope and requirements. Progress should reflect a 99% deliverable.

Poor			Needs Improvement			Average		Exceptional	
1	2	3	4	5	6	7	8	9	10

Teamwork (Weight = 20%)

Demonstrates team approach to solving design challenge that will allow them to move forward in an integrated context. Individual members specifically identify how they have contributed to the project. Progress should reflect a 99% deliverable.

Poor			Needs Improvement			Average		Exceptional	
1	2	3	4	5	6	7	8	9	10

Communication (Weight = 20%)

Clearly articulates the scope of the project and are able to answer questions appropriate up to this timeframe. Written communications are free of spelling and grammatical errors. Graphics convey design concepts in a clear and concise manner. Progress should reflect a 99% deliverable.

Poor			Needs Improvement			Average		Exceptional	
1	2	3	4	5	6	7	8	9	10

Professionalism (Weight = 20%)

Demonstrates recognition of the professional, ethical and societal responsibilities of the design solution. Projects a professional demeanour in physical appearance, organization of thoughts and communication style. Progress should reflect a 99% deliverable.

Poor			Needs Improvement			Average		Exceptional	
1	2	3	4	5	6	7	8	9	10

Comments for team:

Circle individual scores below:

Team member name: ______________________

Problem-solving Abilities (Weight = 20%)

1	2	3	4	5	6	7	8	9	10

Project Deliverables (Weight = 20%)

1	2	3	4	5	6	7	8	9	10

Teamwork (Weight = 20%)

1	2	3	4	5	6	7	8	9	10

Communication (Weight = 20%)

1	2	3	4	5	6	7	8	9	10

Professionalism (Weight = 20%)

1	2	3	4	5	6	7	8	9	10

Comments for team member:

Team member name: ______________________

Problem-solving Abilities (Weight = 20%)

1	2	3	4	5	6	7	8	9	10

Project Deliverables (Weight = 20%)

1	2	3	4	5	6	7	8	9	10

Teamwork (Weight = 20%)

1	2	3	4	5	6	7	8	9	10

Communication (Weight = 20%)

1	2	3	4	5	6	7	8	9	10

Professionalism (Weight = 20%)

1	2	3	4	5	6	7	8	9	10

Comments for team member:

Team member name: ______________________

Problem-solving Abilities (Weight = 20%)

1	2	3	4	5	6	7	8	9	10

Project Deliverables (Weight = 20%)

1	2	3	4	5	6	7	8	9	10

Teamwork (Weight = 20%)

1	2	3	4	5	6	7	8	9	10

Communication (Weight = 20%)

1	2	3	4	5	6	7	8	9	10

Professionalism (Weight = 20%)

1	2	3	4	5	6	7	8	9	10

Comments for team member:

Team member name: ______________________

Problem-solving Abilities (Weight = 20%)

1	2	3	4	5	6	7	8	9	10

Project Deliverables (Weight = 20%)

1	2	3	4	5	6	7	8	9	10

Teamwork (Weight = 20%)

1	2	3	4	5	6	7	8	9	10

Communication (Weight = 20%)

1	2	3	4	5	6	7	8	9	10

Professionalism (Weight = 20%)

1	2	3	4	5	6	7	8	9	10

Comments for team member:

APPENDIX H: SAMPLE DINNER AND EXPO AGENDA

Dinner and Expo Agenda

Welcome by Department Chair……...5:30pm

Dinner…….5:35pm

Remarks by Division Dean…….6:15pm

Remarks by Community Partner……6:20pm

Capstone and Student Project Overview……6:25pm

Capstone Students Excused to Team Tables……..6:35pm

Student Survey Review for Attendees……...6:40pm

Adjourn to Trade Show……..6:45pm

Adjournment……..8:30pm