

Thinking, Communicating, and Practicing: Development of a Senior Design Capstone Curriculum In Information Technology

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Introduction

The University of Cincinnati's College of Applied Science Information Technology (IT) program, founded as the Information Engineering Technology program in 1998, has a significant hands-on component in its requirements. The IT program offers a Bachelor (BS) and Associate (AS) degree option with both day and evening schedules. Learners choose a primary specialization from one of three "tracks", including Software Development, Networking, or Web Technologies. BS learners also choose at least one secondary track specialization from one of five tracks, including Software Development, Networking, Web Technologies, Database or Digital Media. Co-op experience is a vital part of the curriculum; all learners work in alternating quarters starting in their second year of study. BS learners co-op five quarters and AS learners two quarters.¹ In addition to co-op, learners at the College of Applied Science learn by experience through the integration of intensive, hands-on activities built into the courses and through the Senior Design project completed in the final year of study.²

In the IT program, Senior Design is currently a three 3 quarter credit-hour course sequence comprised of Senior Design I, II and III.³ In this paper I discuss the Senior Design capstone project that requires learners to demonstrate proficiency as IT professionals. I outline the context for the course in the overall education of the learners, as well as in their specific field, and offer details of course requirements and how they are fulfilled.

Educational Context

The College of Applied Science's program focuses on IT in its broadest sense encompassing all aspects of computing technology. IT, as an academic discipline, focuses on meeting the needs of users within an organizational and societal context through the selection, creation, application, integration and administration of computing technologies. IT is an academic discipline distinct from computer engineering, computer science and management of information systems. IT encompasses software engineering and development, computer networking and communications, Web technologies, computer security, database management, and digital media technologies. Learners receive a broad education across the IT spectrum as well as technical specialization in the areas of their choice.⁴

The BS degree totals 181 quarter hours. Core requirements are built around TAC-ABET accreditation standards for engineering technology programs⁵ and the emerging standards of the Special Interest Group for Information Technology (SIGITE) of the Association for Computing Machinery.⁶ The degree integrates these requirements to include courses that focus on speaking, writing, project development, humanities and social sciences. Furthermore, several technical classes—for example, in the Digital Media sequence—have activities designed to expose

learners to basic management practices, including teamwork, leadership, professional presentations, budgeting, and time management.

Learners in the IT program also have a common educational experience represented by the General Education requirements. Baccalaureate competencies comprise a major component of the General Education Program. There are four Baccalaureate competencies: Critical Thinking, Effective Communication, Knowledge Integration, and Social Responsibility. Rather than create a set of specific courses to address these, the General Education Program emphasizes the development of these abilities in all undergraduate courses, particularly those that fulfill a Breadth of Knowledge (BoK) requirement. BoK includes ten different academic areas. English Composition is one, and all learners must complete a minimum of two 3 credit-hour English Composition courses. The six areas of Fine Arts, Historical Perspectives, Humanities, Literature, Natural Sciences, and Social Sciences are identified as the Distribution Areas. All learners must complete a minimum of eight 3 credit-hour courses selected from a minimum of five of the Distribution Areas. Quantitative Reasoning, Diversity and Culture, and Social and Ethical Issues are three additional areas, and all learners must complete at least one 3 credit-hour course or an equivalent experience in each. Learners may fulfill certain requirements either through courses or designated experiences. These designated experiences are generally related to a learner's academic program; advisors verify what might be available and appropriate for a specific individual.⁷ Program/Major Requirements, which comprise the third major component of the General Education Program, includes two items: Methodology and Capstone Experience. Methodology encompasses understanding of the systematic methods and history of the discipline/profession. The Capstone Experience is required to demonstrate proficiency in the Baccalaureate Competencies and in the content/skills of the program/major.⁸

The accreditation standards of TAC-ABET and the emerging standards of the SIGITE articulate the requirement for a capstone experience. TAC-ABET requirements state that “capstone or other integrating experiences must draw together diverse elements of the curriculum and develop student competence in focusing both technical and non-technical skills in solving problems.”⁹ The SIGITE emphasizes that “the curriculum must provide students with a capstone experience that gives them a chance to apply their skills and knowledge to solve a challenging problem. The culmination of an undergraduate information technology degree should include a final-year project that requires students to use a range of practices and techniques in solving a substantial problem.”¹⁰

Course Requirements: An Overview of Senior Design¹¹

Learners must complete seven pre-requisite courses and have senior standing to enroll. The seven courses are Technical Writing I and II, PC Systems, Internet Programming, Object Oriented Programming I and II, and Advanced Business Applications. The Senior Design sequence incorporates learning outcomes from the General Education requirements of the University. It is structured to require critical thinking, effective communication, and knowledge integration. In doing the research for their proposal and incorporating the on-going feedback from faculty advisors, learners should demonstrate their ability to analyze, synthesize, and evaluate information and ideas from multiple perspectives. Further, the products of their work should show a fusion of information and concepts and display their competence in aural, visual, and language arts for personal and professional communication.¹²

The Senior Design sequence is “front-end loaded”; that is, the first course covers all topics necessary for learners to participate in the sequence. It is mainly oriented toward lectures and activities to support required work. Independent consultations with faculty advisors are required to help learners define their project, so classes usually do not meet for the full three contact hours. Rather, lectures and activities range from one to one-and-a-half hours, with the remaining time allocated to consultations. Consultations are encouraged with various potential faculty advisors, but especially those in the track on which the project may be focused. At this point no advisors are assigned to specific projects. All faculty are available as potential advisors because no specific assignments are made until the end of the course. This allows learners to have the widest access to faculty to bring multiple points of view to bear on proposed projects.

Course Requirements: Senior Design I

Senior Design I is the first of three courses that focus on a capstone experience. The overall capstone experience requires independent work on a project through three phases: Feasibility (conception), Functionality (design), and Implementation. Projects are required to combine at least two areas in the Information Technology Program: Software Development, Networking, Web Technologies, Database or Digital Media. Topics are selected by learners and approved by the faculty who review a Statement of Need/Area of Inquiry each learner submits by midterm. The Statement of Need/Area of Inquiry includes a preliminary definition of the need, a rationale for its appropriateness as a Senior Design project, and a list of ten references. Topics need to address real problems in concrete terms. Team projects are encouraged, but difficult to arrange because the College is a commuter campus and because so many learners are non-traditional learners with work and family obligations.

The goals of the course are that:

Learners should demonstrate competency in the field of Information Technology by completion of planning for the capstone project that establishes the project's significance and feasibility.

Learners should develop and submit a high quality proposal for the capstone project, including the incorporation of materials from professional literature and other professional resources, a rationale for the proposed project, and a plan for its completion.

Learners should demonstrate an ability to communicate on three key levels:

1) interpersonally, through planned, regular meetings with appropriate faculty to give Progress Reports; 2) in writing, through the completion of the Project Proposal, and 3) rhetorically, through a presentation that articulates the details of the Project Proposal.

To achieve these goals the course focuses on substantive topics that will serve learners in Senior Design II and III. Project management processes provide the central theme for the topics that include:

- The Nature of Research and Resources in Information Technology
- Professional Requirements for Projects
- Design Processes
- Graphical Design
- User Profiling
- Testing and Evaluation
- Writing a Formal Proposal

- Oral Presentation of Technical Proposals

The course results in two major products: first, learners create a formal written proposal, and second, they present the proposal orally. Learners are required to establish the existence of a significant need that requires an appropriate IT solution and to convince the faculty that the need is appropriate as a capstone project demonstrating professional competency. There are several components that are required within the proposal. Most significantly, learners must articulate a need based on applied research. This need must be shown to be substantial because it is supported by appropriate materials from professional literature and/or professional contacts, such as IT practitioners. The references must be relevant, current, complete, and accurate. In addition, learners must offer a solution that is reasonably specific (given that this is the first course in the three course sequence) and that has elements that meet each facet the need. Finally, learners must articulate logistical details, including hardware and software choices, budget details and a timeline that spans the Senior Design sequence. A ten-minute oral presentation requires a summary of the proposal. The presentation must meet professional standards, including use of appropriate visual aids and good oral communication skills.

After the final presentations faculty meet and discuss the projects. If the project is approved, a permanent faculty advisor is assigned. If not, the learner must repeat the course.

Course Requirements: Senior Design II

Functionality is the theme of the second course in the Senior Design sequence. In it, learners have an assigned advisor with whom they work to complete the project. The only full class meetings are on the first day to review goals, expectations and requirements, at midterm to review presentation requirements and to answer questions about expectations, and for the final two classes during which presentations are given.

The goals of the course are that:

Learners should demonstrate technical and logistical competency in the field of Information Technology by completing planning for and beginning implementation of the capstone project.

Learners should submit final project details in a report (the "Design Freeze") to the IT faculty.

Learners should deliver, at a minimum, a preliminary product component using appropriate hardware and software that demonstrates "Proof of Concept" through a "Working Quick Prototype".

Learners should demonstrate professional attitudes by submitting high quality work and conducting themselves in a professional manner.

Learners should demonstrate an ability to communicate at three key levels:

- 1) interpersonally, with planned, regular meetings with appropriate faculty, and especially the faculty advisor, to prepare Progress Reports; 2) in writing, with the completion of the Design Freeze report and submission of regular Progress Reports, and 3) orally, with a presentation that demonstrates the "Working Quick Prototype/ Proof of Concept " and summarizes the concrete plans for the final phase of the project: Implementation.

Since the key topics for the Senior Design sequence have been covered in detail in Senior Design I, the time for Senior Design II is allotted mainly for consultations with faculty advisors and completion of a Working Quick Prototype that demonstrates Proof of Concept. The principle outcome of Senior Design II is evidence of the functionality of the project proposed in the first course. The Design Freeze is the written report for Senior Design II. It extends and refines the proposal to give a clear picture of the intended final product. It extends the proposal in four key ways: first, it gives a specific production description and intended use; second, it offers a specific user profile (or profiles, for products intended for multiple user groups); third, it spells out design protocols that give a clear picture of the way the product will function (e.g., flowcharts for digital media projects) and the way it will “look and feel” (e.g., user interface design); and fourth, it defines a testing plan. It refines the proposal in two key ways: first, it gives more specific information about logistics, including final hardware and software choices, a final budget and a final timeline; and second, it gives precise deliverables, with a statement of specific features that will be incorporated into the final product. A ten-minute oral presentation requires a summary of the Design Freeze including a demonstration of a prototype. The presentation must meet professional standards, including use of appropriate visual aids and good oral communication skills.

Course Requirements: Senior Design III

Implementation is the theme of the third and final course in the Senior Design sequence. In it, learners continue consultations with their assigned advisors and independent work on their product. The only full class meetings are on the first day to review goals, expectations and requirements, at midterm to review presentation requirements and to answer questions about expectations, and for the final two classes during which presentations are given.

The goals for the course are that:

Learners should demonstrate competency in the field of Information Technology by completing the capstone project.

Learners should submit a final written report that incorporates the Project Proposal, the Design Freeze, and appropriate documentation and summarizing information about their projects to the IT faculty.

Learners should demonstrate professional attitudes by submitting high quality work, conducting themselves in a professional manner, and meeting deadlines.

Learners should demonstrate an ability to communicate on three key levels:

1) interpersonally, with planned, regular meetings with appropriate faculty, and especially the faculty advisor, to prepare Progress Reports; 2) in writing, with the submission of regular Progress Reports and the final report, and 3) orally, with a public presentation that presents the final working project, including the rationale for the project, the structure of the project, and a demonstration of the project.

The principle outcome in Senior Design III is the implementation of the completed project. The Final Report is the document that incorporates the Project Proposal and the Design Freeze from the first two courses with the addition of two sections. For one of the additional sections the learner must offer a written explanation of Proof of Design on two levels. First, the learner must articulate how the deliverables offered in the Design Freeze have been realized, and second, the learner must report results of the testing plan. For the other additional section, the

learner must discuss his/her conclusions and recommendations, speaking mainly to the level of success in meeting deliverables and what else he/she might have done differently. A fifteen-minute presentation gives a brief summary of the project's background and emphasizes a demonstration of the fully implemented product. The demonstration is the point of departure for a discussion of the Proof of Design by showing the degree to which the deliverables presented in Senior Design II have been met. The presentation must meet professional standards, including use of appropriate visual aids and good oral communication skills.

Conclusion

The Senior Design sequence for the IT program is designed for learners to show professional competency. It requires project management skills from establishing the feasibility of a project to its final implementation. Its activities demand critical thinking skills, effective communication, and sound integration of knowledge from the field of IT.

As the capstone project, it is designed to assess program outcomes defined in TAC-ABET Criterion 2. It specifically requires learners to demonstrate:

- an appropriate mastery of the knowledge, techniques, skills and modern tools in IT,
- an ability to apply current knowledge and adapt to emerging applications of mathematics, science, engineering and technology,
- an ability to apply creativity in the design of systems, components or processes, an ability to function effectively on teams,
- an ability to identify, analyze and solve technical problems,
- an ability to communicate effectively,
- an ability to understand professional, ethical and social responsibilities.¹³

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Biographical Information

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