The Unintended Consequences of Capstone as a Writing Intensive Course

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Many capstone instructors naturally strive for excellence in all aspects of their course. While this is admirable, actions taken to cause excellence in one aspect of a course can lead to the effect of unintended consequences that compromise other aspects of the course. Such a cause-effect situation occurred in the capstone course of the School of Mechanical, Industrial, and Manufacturing Engineering at Oregon State University (OSU). Efforts to achieve excellence as a Writing Intensive Course (WIC) at OSU lead to capstone becoming a superb writing course, receiving praise from an internal review. However, this excellence came at the expense to the technical content of the course. Course instructor and graduate teaching assistant time and effort expended in support of writing instruction were not available for student technical consultations and instruction. Report length grew as students sought to minimize time in revising report content. Most significantly, design decisions were made based on the impact they would have on the required report content. Specifically, improved designs were not pursued due to the need to revise report content to describe the changes. Currently changes are being implemented to refocus the course on technical excellence. It is hoped others can learn from these experiences.

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Introduction

In the College of Engineering at Oregon State University (OSU), capstone senior project has been designated as a *Writing Intensive Course* (WIC). This is consistent with research showing that teaching students to communicate effectively is an appropriate outcome for capstone[1]. Each department or school within the college has chosen to implement these requirements in a way that fits their individual needs and curriculum. However, care must be taken in such implementations. Research has shown that communication assignments can detract from engineering focus[2]. The School of Mechanical, Industrial and Manufacturing Engineering (MIME) has executed a process of implementation that has evolved over time and had, unfortunately, moved the course to a state of a "writing course with an engineering project" rather than an "engineering course with a writing component". This shift was primarily driven by three unintended consequences of pursuing a capstone course that excelled in student writing instruction. Recently, changes have been made to the course to address loss of focus on engineering excellence. The purpose of this paper is to describe these unintended consequences and how they occurred in the hope that others can avoid them. This paper provides a summary of the WIC requirements at OSU, how they were implemented in MIME Capstone, an examination of the unintended consequences, and a brief description of remedial actions currently underway.

WIC Requirements

All bachelor's degree programs at OSU must include a WIC[3]. The purpose of these courses is to teach students how to properly write in the major field. The rationale behind WIC is that in addition to the writing skills and practice gained in freshman composition and junior-level writing courses (e.g. technical writing), students also need to learn to write specifically as members of the discipline in which they have chosen to major[4]. To that end, WICs at OSU are existing courses in a student's major in which a significant amount of writing normally occurs or which can be reasonably adapted to include significant writing. The WIC component is added to the existing courses field-specific content. For example, an existing biology laboratory course could become a WIC by suitable modification of the normally-occurring lab report writing requirement. Note the intent is that in becoming a WIC, an existing course neither loses nor compromises any of its original core content. WICs are typically taken in the student's junior or senior year preferably after other required writing courses. WICs introduce students to the genres, purposes, audiences, content, and conventions of writing in their major. Student writers gain experience

with the resources used in their field and the formats and documentation style used to communicate knowledge.

The OSU faculty senate has adopted, as part of the Baccalaureate Core curriculum, five criteria for a WIC[5]. They are the key guidelines for a WIC at OSU and are summarized as follows:

- Criterion 1: Writing intensive courses shall use student writing as a significant approach to learning.
  - The course shall require at least 5,000 words (including drafts, in-class writing, informal papers, and polished papers); 2,000 words of this total should be in polished papers which students have revised after receiving feedback and criticism;
  - Students should expect to revise graded writing based on feedback and criticism.
- Criterion 2: Writing intensive courses shall base a significant part of the grade on evaluation of writing. Grades for papers should form at least 30% of the overall grade, with at least 25% of the overall course grade based on evaluation of individually written papers.
- Criterion 3: Writing-intensive courses shall focus on content related to the major disciplines and be taught by faculty knowledgeable about that discipline
- Criterion 4: Writing intensive courses shall discuss writing issues pertinent to that discipline, as such issues apply both academically and professionally.
- Criterion 5: Writing intensive courses shall be upper division.

In adapting an existing course to become a WIC, some of these requirements are easily or automatically met such as "shall be upper division" and "taught by faculty knowledgeable about that discipline". Others can require minor changes in course grading or course scheduling such as "shall base a significant part of the grade on evaluation of writing" or "shall discuss writing issues pertinent to that discipline". However, others, depending on interpretation, can lead to significant changes in course deliverables and can add considerable grading burdens such as "2,000 words of this total should be in polished papers which students have revised after receiving feedback and criticism".

MIME Capstone as a WIC

From its initial designation as a WIC in 2004 to the 2016-17 academic year, the MIME capstone program allocated increasing personnel, course deliverables, percentage of course grade, and emphasis on the teaching and evaluation of writing for students enrolled in the course. At its peak in the 2015-16 academic year, MIME capstone had grown to include eleven written papers of varying length. These are briefly described below including an indication of whether the paper was jointly written by the student project team (denoted "team") or individually written by each student (denoted "individual") :

- Background Research Brief (Individual): Due early in the course, it describes project scope and literature review results.
- Preliminary Proposal, Final Proposal, and Final Report (Team): These three reports, due respectively at weeks 5, 10, and 20 of the 20-week course sequence, document in detail the design process in terms of designs considered, design selection and technical specification, testing procedures, prototype construction, test results, and design modifications made.
- Team Charter (Team): Due early in the course, this document describes team roles, responsibilities, and conflict resolution methods
- Capstone Communication Inventory (Individual): Completed early in the course, this submission documents student writing proficiency goals for the course
- Mid-Course Goals review (Individual): Due in week 10 of the 20-week course, this document discusses perceived progress made in meeting the proficiency goals set previously
- Executive Summary Draft (Team): Due early in the second 10-week term, this is a draft of the executive summary which will appear in the Final Report
- Capstone Experience Memo (Individual): Due at the end of the course, this is a reflection of the student's capstone project experience.
- Peer Evaluation of Team Performance, Term 1 (Individual): Completed at the end the first ten-week term, this is the student's perception of the contributions of his team mates to the project.
- Peer Evaluation of Team Performance, Term 2 (Individual): Completed at the end the second ten-week term, this is the student's perception of the contributions of his team mates to the project.

In addition to the written papers, the course included two formal oral presentations and a design exposition poster.

Unintended Consequences

When initially designated as the school's WIC course in 2004, the goal was to achieve excellence in all aspects of the course. The pursuit of WIC excellence was achieved and culminated in 2014 with the OSU

Baccalaureate Core Committee category review of WIC courses rated the MIME Capstone WIC as exemplary stating

"… we are deeply impressed with the effort you have expended designing and implementing this course; you are a model for the College of Engineering and OSU"

While these comments were gratifying, the superbly thorough WIC content of MIME capstone was accompanied by a number of unintended consequences. These are categorized as resource allocation, report length, and design revision. These will each be described in the following subsections.

Resource Allocation

The pursuit and achievement of WIC excellence was often translated to not simply meeting the faculty senate criteria but in significantly exceeding them. For example, the WIC total-course word-count requirement of 5000 (see Criterion 1 above) was typically met or exceeded by the Final Report alone. In some cases, Final Reports consisted of over 50 pages, six or more appendices, and over 40,000 words. Another example was the requirement of criterion 2 for the "evaluation of individually written papers". This was implemented via a complex writing-and-grading scheme of dividing a single team-written report into individually written sections which were combined into a final version. Each graded iteration of a report contained feedback and criticism on each student's individually written sections which they could address in subsequent revisions and papers. Implementation of this scheme required teams of three students which necessitated managing course enrollment.

As might be expected, the grading burden of this large quantity and grading complexity of student writing was considerable. For example, the grading of the Final Reports involved at least five individuals. An engineering graduate teaching assistant graded reference citation format and some content. The MIME Capstone Technical Instructor (a full-time position) or a senior instructor graded technical content. A writing graduate teaching assistant graded some writing content. Either MIME Capstone Writing Instructor (a full-time position) or the Communication Curriculum Director (also a full-time position) graded the remaining writing content. Additionally, faculty project advisors were asked to provide report grades. The sum total of time spent grading each paper could reach several hours per team report in a class containing 50 or 60 project teams.

This considerable allocation of resources to WIC excellence had the unintended consequence of compromising the delivery of technical content in the course, reducing interactions with students, and reducing feedback given to students on technical topics. Both instructors and graduate teaching assistants were driven by a need to stay in their offices, "get the grading done", and provide copious writing feedback to students. While beneficial, it came at the cost of reducing student-instructor meetings and discussion of engineering project challenges and solutions.

The allocation of staff time from engineering topics to writing changed over time as emphasis shifted to WIC excellence. When the MIME capstone course was first designated a WIC in 2005, neither the course instructor nor the course graduate teaching assistants were directly involved in the grading of writing. The grading was done by project faculty advisors and the Communication Curriculum Director and in terms of the time allocation from capstone staff consumed approximately 25% of the fulltime equivalent of one person. By 2016-17 the grading of writing was a major duty of two course instructors, two graduate teaching assistants, and the Communication Curriculum Director consuming the equivalent of approximately three fulltime people. Even allowing for a doubling of enrollment over this time period, this simple numerical metric indicates a six-fold increase in capstone staff time allocated to the grading of writing. For the instructor and graduate teaching assistants this represents a loss of time spent on technical topics.

Report Length

A core component of WIC excellence was the three-report sequence of the Preliminary Proposal, Final Proposal, and Final Report. These three reports spanned the entire course and documented all steps in the design process. They were cumulative in the sense that the content of the Preliminary Proposal describing, for example, design alternatives considered, was included in the Final Proposal which added content on the design selected and component specification. Similarly, the content from the Final Proposal was included in the Final Report which added a description of the prototype build, testing procedures, an explanations of test results, and specifications for design modifications made. This repetition of content was very effective in meeting the Faculty Senate guideline of "revise graded writing based on feedback and criticism" (Criterion 1) however it was also the cause of an unintended consequence.

It is not uncommon for projects to change in scope and capstone projects are no exception. Historically, approximately 25% of MIME capstone projects have some form of scope change. The degree of change varies from minor modifications of individual requirements to nearly complete project redefinition. Such changes are not unexpected. What was unexpected was how the students dealt with these scope changes. In the sequence of Preliminary Proposal, Final Proposal, and Final Report, project scope is normally described in the first paper, the Preliminary Proposal. If

a scope change occurred after the Preliminary Proposal was written, the expectation was that students would revise the content accordingly prior to including it in either the Final Proposal or Final Report. However, not one team choose to do this. All students that experienced scope changes choose to keep the original Preliminary Proposal content and address the change by adding sections to the subsequent reports. This aversion to rewriting sections of the report contributed to overly long reports with awkward structure.

Design Revision

The most significant of the unintended consequences was the direct impact on design revisions. As described previously, the Preliminary Proposal, Final Proposal, and Final Report were written sequentially with content carrying forward from one to the next. Of particular importance is that the detailed specification of the selected design was given in the second of the three reports, the Final Proposal. The third paper, the Final Report, contained a description of the construction of the prototype and testing results. During testing, it is likely that shortcomings become evident compelling changes to the selected design. In many cases this occurred. However students would not pursue an obviously beneficial change to their selected design due to such a change necessitating modification to their written reports. The report-writing requirements were so great that students would knowingly produce an inferior design solution rather than implement an improvement and update the associated reports.

Remedial Actions

Due to these unintended consequences and other factors, in 2016-17 MIME capstone was significantly changed. It is still the MIME WIC, but with the acknowledgement that the achievement of WIC excellence had been compromising the technical content of the course. Changes include reduction in the number of reports, reduction of the length of reports, changes in the content of course lectures, and changes in the staffing of the course. These changes are on-track to provide MIME students with a technically excellent capstone experience which meets, but likely does not greatly exceed, all WIC requirements.

Conclusions

The purpose of this paper is to describe how, through the pursuit and achievement of excellence in capstone writing instruction, technical content and project deliverables were unintentionally compromised. Specifically, the cost of excellence in writing included (i) a disproportionate allocation of instructor and teaching assistant time and effort to the grading of writing, (ii) excessively lengthy reports due to student aversion to revising existing text, and (iii) technically inferior project deliverables also due to student aversion to revising existing text. These consequences were the result of sincere efforts to achieve excellence in writing instruction; however, they unavoidably compromised the technical content of the course. Changes have been made to the course to focus first on technical excellence. It is hoped that other capstone instructors can learn from this.

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