INSTITUTIONAL ADAPTATION OF THE GREENFIELD COALITION'S CAPSTONE DESIGN COURSE

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SUMMARY

In most capstone design courses, students go through the complete design process starting with a description of the problem and ending with a prototype. Many schools have one or two-semester-long classes where students work in groups or individually. The capstone design course in the Division of Engineering Technology at Wayne State University (WSU) falls into this category. The National Science Foundation funded Greenfield Coalition's (GC) capstone design course, however, is unique since students are given credit for their projects based on real-work experiences. This paper discusses how this is done at the Greenfield Coalition and the implications of adapting this course to Wayne State University's Division of Engineering Technology (ET) curricula.

INTRODUCTION

The last two decades have been marked by the globalization of markets, technology, and competition. This transformation has necessitated sharpened skills and competencies in engineering applications that are relevant to the business community's needs. An important area in which the need for sharper competencies has increased recently is engineering technology. In this context, the many industry-university-government partnerships such as the Greenfield Coalition are emerging as platforms in which resources are leveraged effectively in the journey toward achieving industrial and academic excellence in global competition. The GC is a National Science Foundation funded project, which sets a new paradigm in manufacturing engineering and technology education. One of the key goals of the coalition is the development of experiential, learner-centered curricula designed and delivered through collaboration between university and industry partners. Engineering Technology degree candidates are full time employees of the Center for Advanced Technology (CAT) where their real world experience on the job forms the centerpiece of their education. This is an example of the type of transformation taking place in industry-government-academe partnerships, which have been changing our traditional notions about engineering and technology education, especially the teaching of engineering design at universities.

Unlike the traditional engineering design process ranging from need identification, concept testing, feasibility analysis, mechanical design, prototype development, and aesthetic improvements to commercialization [1-15, 17-22], the GC candidates experience engineering design through an immersed manufacturing environment. They are involved in the operation, design, and quality control processes in the manufacturing plant. Because of this unusual experience, in the capstone design course, the GC candidate's *learning* is *validated* in engineering technology design instead of having them design a separate complete project in the design course. The candidate's hands-on manufacturing project experience and interdisciplinary knowledge during his/her tenure at the CAT are assessed in design project's validation.

This paper discusses the institutional adaptation of this GC creative course to the Division of Engineering Technology at Wayne State University. Also discussed are the educational and administrative implications of this adaptation.

CURRENT SITUATION IN ET

In the one-semester capstone design course in the Division of Engineering Technology at WSU, students work individually on solving medium scale design project, where they design, then build and test their work. In this process, students apply previously learned course content to meet stated objectives. The course meets once a week and is composed mainly of lectures from experts in industry. Typical lecture topics include library or data base literature search, entrepreneurship, intellectual property, technical report writing, and professional registration. Each student works with a faculty mentor from his/her area of interest on a regular basis. Each student starts with a concept of a design and completes a working prototype by applying content knowledge from his/her major field of study. Students are provided a simple template to guide them through their projects. This template includes instructions on what the report should contain and typical mistakes encountered in project write-up. Students are also given samples of graded, previously written student reports to use as a guideline in preparing their own reports [16].

There are two deliverables for this course, a written report submitted at the end of the semester, and an oral presentation. The faculty mentor who is responsible for 75% of the total grade grades the project report. Project quality and effort and the technical writing are the dimensions of grading the report. At the oral presentation, where students present their work, everyone in the class fills out the presentation evaluation form and provides written comments. The course-coordinating professor then gathers this data and assigns the remaining 25% of the student's grade, which includes class participation as well.

GREENFIELD COALITION'S CAPSTONE DESIGN COURSE

Unlike this traditional model, the GC candidates work under contract with leading manufacturing companies (such as Ford Motor Company, General Motors, DaimlerChrysler, American Axle, etc.) to design and build products while they receive formal education at Focus:HOPE, a civil rights organization. The candidates learn through hands-on experiences in a plant setting as they combine practice with theory in the manufacturing facility, the

Center for Advanced Technologies (CAT). In this environment, the candidates rotate through different jobs, thus acquiring different skills. In this case, instead of having the candidates design a separate but complete project, the candidate's design ability is assessed by *validating* his/her learning through a special set of *questions* in the manufacturing environment. For example, they are asked to critically evaluate their design and comment on lessons learned from their experiences.

While practicing engineering design at the CAT, candidates are asked to collect as much information about their project as possible and keep that in their portfolios. When they are close to completion of their job rotation, they are asked to choose one of the projects on which they have worked during their tenure. It is recommended that they choose the project on which they have the most information collected. Each candidate accesses the class information on-line (Fig.1). This web-based information contains a course syllabus, information on how to write a proposal, a tutorial (Fig. 2), a template, and oral/written forms.

In the first class meeting, candidates talk about their chosen projects. They are then given a project from an earlier semester, and are asked to critique it before they formally submit their project proposal.

The course is built around three objectives:

1. Technical Design Competency Development: Validate a better understanding of and appreciation for, how the engineering design process ought to work. Establish that candidates have acquired technical design competency in engineering technology. In order to validate this objective, candidates critique other candidate's design projects and generate their own proposals. This is measured through weekly progress reports (including the critique) and a written proposal, both graded by the instructor. This is rewarded by a 1/3rd of the student's grade.

2. Human Skills Development: Validate skills in communication and organizational/team membership, develop a mindset of "team work" and validate effectiveness in oral presentation. This is measured by validating the effectiveness of candidate as a "team" player, and is graded by his/her supervisor while working under him/her, which is found in his/her portfolio. Another measure of this course objective is the oral presentation of a candidate's project, which is graded by the audience (instructor, cohorts, and industrial partners). The instructor then integrates cohorts' and industrial partners' assessments into his/her own before assigning grades. In this context, the instructor provides the cohorts and industrial partners with an "Oral Presentation Evaluation Form" which includes the criteria and weights on which the candidates are graded. A candidate can find this form under "Forms" of the course homepage.

   The measure with which this skill is evaluated is the analysis and evaluation of survey instrument results and interviews with co-workers, as well as the grades received on the oral presentation. This is rewarded by a 1/3rd of the student's grade.

3. Synthesis: Synthesize and validate candidates' learning in the former two phases and in his/her course work throughout his/her program, and his/her internalization of key dimensions of the design process (assessment of degree of integration). This is measured by weekly progress reports graded by the instructor. Another measure is the final written report, which is evaluated by both the instructor as well as the industrial partners of the GC. This is rewarded by a 1/3rd of the student's grade.

ADAPTATION TO WAYNE STATE

This course is in the process of adaptation to the Division of Engineering Technology model at WSU. This is a natural process since most students in ET work fulltime and is encouraged to utilize their real-world knowledge and skills. However, it may not be feasible to implement this fully, since there are still some students who have not had this kind of real world experience. For those students, there is still a need to have a more traditional setting where they go through a lecture and a complete design process. However, for students who are in a real work place setting, this adaptation comes very naturally, it also gives them a sense of internalization of their work.

The process is challenging for both the student and the faculty member. Since the product has already been designed and implemented, most likely somewhere else, the student's ability to re-construct the design steps, think about how else it could have been designed, and laying out the "lessons learned" becomes a challenge. We have found that if the project is designed recently, the student might have more recent information about the project. In GC's case, all the candidates are in the same manufacturing environment; therefore, even if they are in the next rotation, they still get the information they want. However, at Wayne State, there are some cases in which the student might have changed the job environment and might not have all the necessary information or data to complete their projects. When this is the case, each faculty member decides, in each individual case, to allow the student to choose a project, which he/she may have completed at work. In a faculty member's case, the ability to validate the student's work relies on both the student's written report and his/her oral presentation.

CONCLUSIONS

This paper portrays the traditional model of teaching a capstone design course in ET of WSU, and then talks about The National Science Foundation funded Greenfield Coalition's (GC) capstone design course, where students are given credit by validating their learning about their design. Also discusses the institutional adaptation of this course to the Division of Engineering Technology at Wayne State University. It is believed that administratively there is not much difference between the two models, and each mentor on a case-by-case basis does the implementation.

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BIOGRAPHY OF THE AUTHORS

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Attila Yaprak: Attila Yaprak, Ph.D. is a Professor of Marketing and International Business at Wayne State University. He is a former Associate Dean for Research at the Business School, and the Executive Secretary of the Academy of International Business. He has published widely in scholarly journals, and is the recipient of many grants from public and private funding sources.

Mulchand S. Rathod: Mulchand S. Rathod, Ph.D., P.E. joined WSU as Professor and Director of the Division of Engineering Technology in 1987. He earned his B.E. (Mechanical) degree from Sardar Patel University in 1970; and M.S. in 1972, Ph.D. in 1975, both in Mechanical Engineering from Mississippi State University. At WSU, he has been instrumental in starting four new under-graduate and a graduate programs. He established student chapters of SME and Tau Alpha Pi and is the founding leader of the Professional Order of Engineering Technology.

His prior appointments include State University of New York at Binghamton, Tuskegee University, Jet Propulsion Laboratory, and IBM. A registered Professional Engineer, he is active in ASME, SME, ASHRAE, and ASEE. He has served as a Commissioner on the TAC of ABET. A holder of numerous publications and inventions, he is listed in several Who's Who publications. He was awarded the 1995 Dedicated Service Award, 1998 Ben C Sparks Medal, and 2001 BMW award by ASME and Certificates of Recognition by NASA and IBM for technical innovation. Also, a recipient of a number of grants and contracts and a Fellow of ASME, Dr. Rathod is a nationally known leader in Engineering Technology education arena.

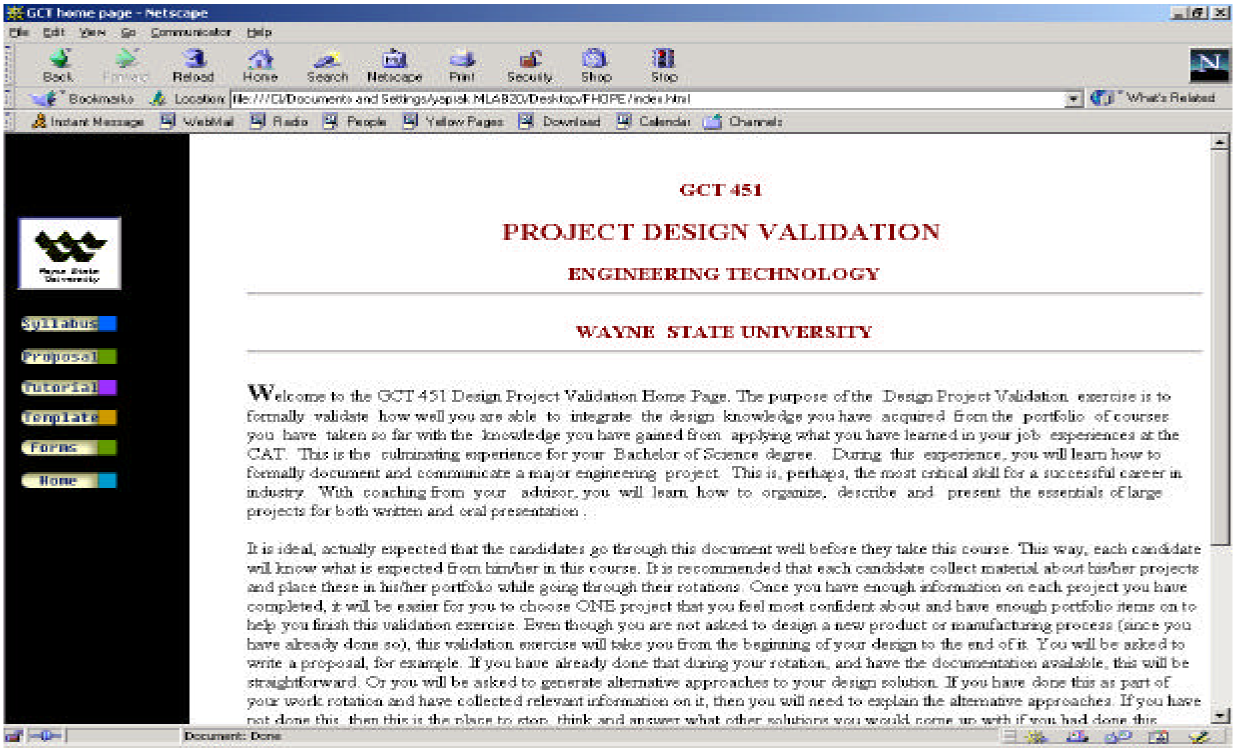

Fig.1 Project Home Page

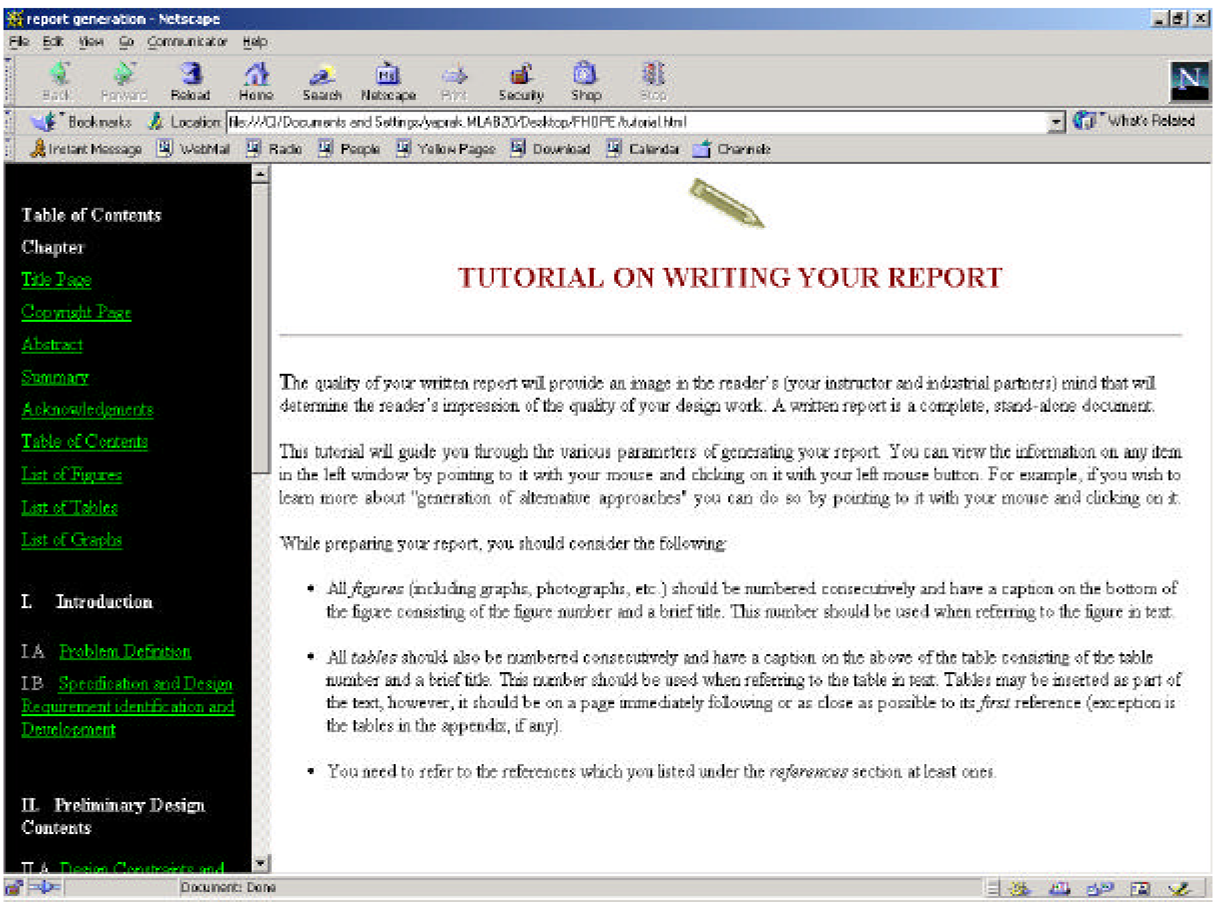

Fig. 2 Tutorial