INTERNATIONAL SENIOR CAPSTONE DESIGN INITIATIVE

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Introduction

Every student in the Mechanical Engineering Technology Department must complete a Senior Capstone Design Project course sequence as a requirement for the partial fulfillment of the Bachelor of Science in Mechanical Engineering Technology degree. Mechanical Engineering Technology students at the University of Cincinnati must design, build and test their product for the satisfactory completion of the Senior Design Project course sequence. At many institutions the capstone projects do not include the build and test components.

In today's world, parts and products are designed, manufactured, tested and sold in various locations/countries for customers around the world. This means that engineers and engineering technologists must become familiar with global design, manufacturing, testing and distribution methods and practices.

This paper describes a plan to institute an international, team-based Capstone Senior Design Project sequence. The plan calls for cooperation between foreign academic institutions, multi-national corporations and the University of Cincinnati.

Current Practice

At present, students propose an idea for a project of their own choosing and refine it in the form of a formal proposal, which upon approval becomes their senior project. In practice, ideas come from industry, personal interest and/or departmental laboratory needs. They are advised to think as if they were pitching their ideas to a group of venture capitalists. If someone funds it, then the project moves forward. Each project has a faculty advisor. The relationship between the faculty advisor and the student is the same as between a project engineer and his/her supervisor.

They may select an industrial project, laboratory equipment, consumer product, personal needs, hobby related, or software interface project. The topics are broadly categorized into three major areas of specialization: Design, Manufacturing and Energy. Currently, the majority of the projects are individual and local in nature.

The projects are carried out in four stages: Proposal, Design, Manufacture & Test, and Communication & Documentation.

Proposal
The formal proposal submitted by the students includes the following:

- **Informative Abstract**
- **Problem Definition**
- **Research Summary**
  - Patents
  - Current Products
  - Interviews
  - Surveys and results
- **Project Objectives**
  - Identification of Needs
  - Analysis of Needs
  - Measurable Objectives
  - Project Deliverables
- **Project Resources**
  - Estimated Budget
  - Time Schedule
- **References**
- **Appendices**
  - Annotated Bibliography
  - Summary of Survey
  - QFD
  - Other

Design
The students must take the initiative in making all the design and manufacturing decisions for the project. It is their responsibility to make sure they are on schedule and will finish the project with minimal supervision. All the design activities are documented in two different forms:

Weekly reports, describing the activities and results obtained during that week as well as plans for the following week and the student's own assessment of the progress toward completion of the project.

A comprehensive, professionally written design reports containing the following:

- Project Description
- Assumptions
- Patent Search
- Literature Search
- Customer Surveys
- QFD (House of Quality)
- Technical Specifications
- At least three Conceptual Design alternatives
- Selection of the "Best" design
- All pertinent Analyses
- Gantt Chart
- Proof of Design Document
- Drawings
- Bill of Materials

Manufacture and Test

Students having completed the design phase of their projects now must build and test their designs. This reinforces the practical orientation of our program.

They are expected to manufacture the necessary parts and assemble the prototype. The exceptions to this requirement are parts requiring sophisticated or precise machining, using equipment not available in our manufacturing laboratories or approved commercial components. Manufacturing these parts gives them an appreciation for details and tolerances to be incorporated into the design to facilitate manufacturing and assembly.

The finished prototype is tested and debugged to verify that it meets or exceeds the technical specifications. Testing methods vary from one prototype to another. In some cases, well established standards exist for testing, while in others, testing methods are defined by the student. This might include designing and building a special test apparatus. Test results must satisfy customer needs as outlined in their project proposal. The customers will test the prototype when applicable. Finally, the test results must prove that the product specifications are met.

Testing of industrially sponsored projects is usually performed at the sponsoring company's premises. They must demonstrate their device to the "Primary Customer", who, after all, is the person or company who is going to use it.

Communication & Documentation:

The project documentation includes: an oral presentation, a project report, and participation in a technical exposition (Tech Expo). Each student must give a fifteen-minute oral presentation describing all aspects of their senior capstone project, including prototype and production run costs.

A professionally written, comprehensive project report, describing every aspect of the designing, building and testing of the device, with the appropriate analyses, bill of materials, drawings, projected production and manufacturing costs, etc. is submitted for the partial fulfillment of the course requirement

Plan

Region Selection

Our current plan is to focus working with two Latin American countries. Latin America was selected because of its proximity to the US, NAFTA, the relatively low travel cost and the authors' knowledge and familiarity with institutions in those countries. All three authors have collectively presented papers, conducted workshops, chaired panel discussions, organized international conferences, as well as taught courses as exchange faculty members in these countries.

Team Composition

The initial plan calls for three teams, each having three members. Each team will have a representative of each country, and will have an assigned advisor. The advisors will also be from the three different countries.

Project Selection

The design teams will be working on industrial projects. Each advisor will be responsible for obtaining suitable projects from industry. It is envisioned that the supporting companies will be multi-nationals, preferably having plants and/or offices in both the US and the other two countries.

One project will be selected by the advisors to be the one worked on by all three teams in a given year. The others will be used in subsequent years.

Implementation

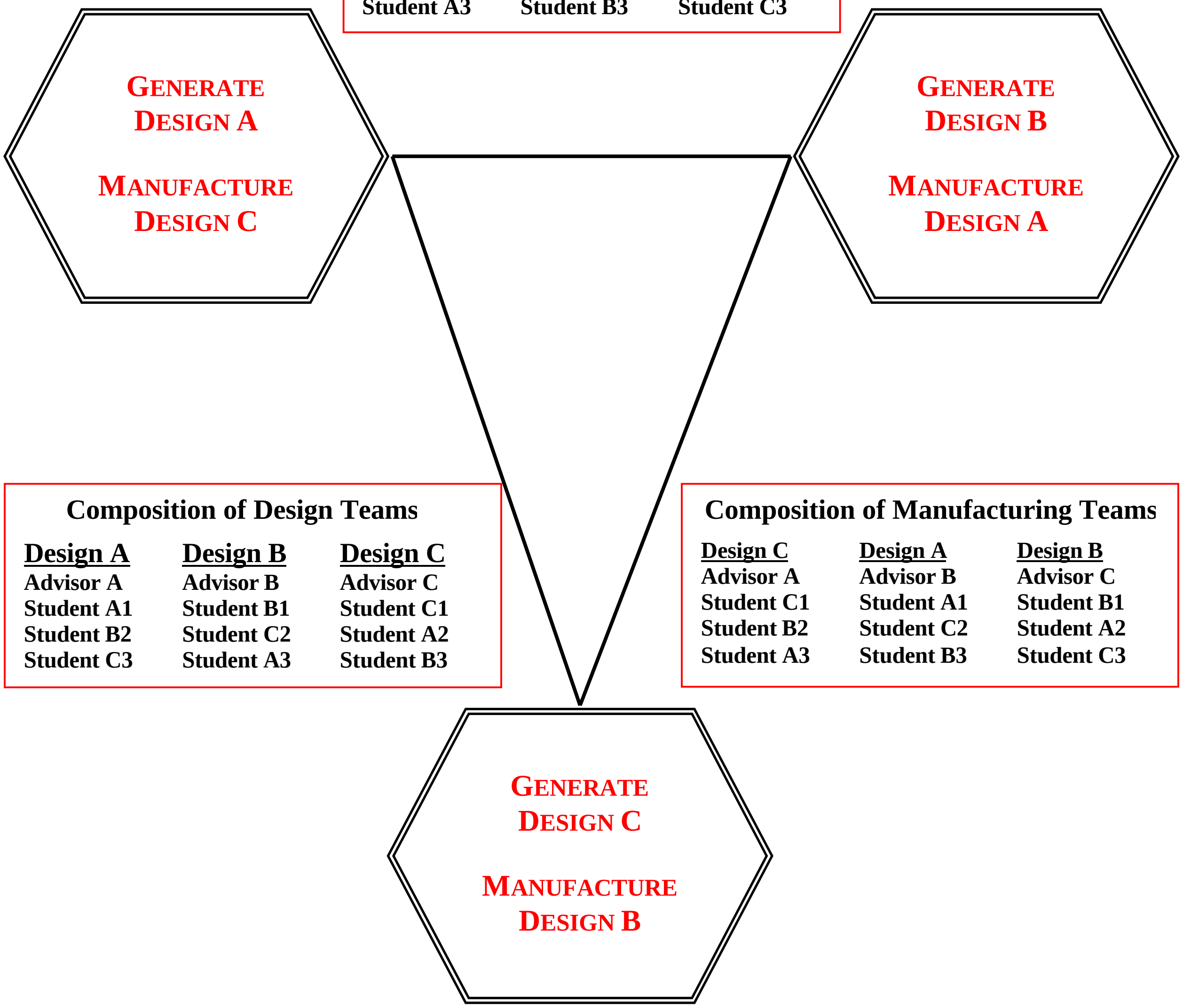
Design

The technical requirements outlined in the Current Practice section will remain the same and have to be fulfilled by the international design teams. Ideally, all team members would be working at the same location during the design phase. However, this becomes impractical due to logistical difficulties and financial reasons. Therefore, the team members will work at their home institutions, using modern design communication methods, such as "3D TeamWorks" or "Metaphase". Email, Internet and fax will also be used as needed. Regular communication with the assigned advisor will also be the team's responsibility and will help to coordinate the design effort. A team generated Design Report, including the requirements set forth in the Current Practice section, and including working drawings and a bill of materials will be submitted at the end of the Design period.

Design and Manufacturing Locations and Team Compositions

Participants

Country A	Country B	Country C
Advisor A	Advisor B	Advisor C
Student A1	Student B1	Student C1
Student A2	Student B2	Student C2
Student A3	Student B3	Student C3



Composition of Design Teams

Design A	Design B	Design C
Advisor A	Advisor B	Advisor C
Student A1	Student B1	Student C1
Student B2	Student C2	Student A2
Student C3	Student A3	Student B3

Composition of Manufacturing Teams

Design C	Design A	Design B
Advisor A	Advisor B	Advisor C
Student C1	Student A1	Student B1
Student B2	Student C2	Student A2
Student A3	Student B3	Student C3

Manufacture and Test
In practice, many parts and products are designed in one country and manufactured in another. All three designs completed during the previous phase will be manufactured and tested in a country other than the one in which the design originated. The design origin is considered to be the country of the faculty advisor.

In order to simulate this situation, the student teams will be reorganized for the manufacturing and testing phase. The new manufacturing/testing teams will have one member from the original design team and one member each from the other two design teams. (Fig. 1) Now the advisors will work with the design, which will be manufactured in their own countries. Each manufacturing/testing team will be located in the country in which the manufacturing and testing is to take place, for a five-week period. The advisors will be responsible for ensuring that the product/prototype satisfies the specifications.

Communication/Documentation
All manufacturing teams will make an oral presentation and prepare a written final project report. These reports will adhere to the requirements described in the Current Practice section. All three presentations will be held at one location and the industrial sponsor will be invited to attend the presentations. If feasible, all the resulting products/prototypes will also be displayed.

Budget
It is estimated that the total cost of this International Team Based Capstone Design initiative will be $24,000 per year. The bulk of the cost is travel related. The cost of computers, workstations, communication tools, salaries and benefits are not included in this budget and will be the responsibility of each participating institution. Table 1 depicts the detailed cost breakdown.

Item	Cost in U.S. $
Researching Project	1,000.00
Finalizing Project Selection (2 Advisor travel)	3,000.00
Manufacturing Phase	
Travel Cost, 6 Students	4,000.00
Housing and living expenses, 6 Students	3,500.00
Presentation Costs	
Travel Costs, 8 individuals	5,000.00
Living Expenses, 6 Students	1,500.00
Living Expenses, 2 Faculty Advisors	1,000.00
Administrative and Support	5,000.00
Total	**24,000.00**

ESTIMATED COST
Table 1

The plan calls for each home institution to cover all expenses for their students and faculty advisors for all project related activities except during the manufacturing phase. Lodging during the manufacturing phase of the project, for the incoming foreign students will be the responsibility of the host institution. Students will be responsible for their personal expenses and food during this phase. In addition, the participating institutions may provide scholarships to encourage student participation and help defray costs.

The author's have applied for a $15,000.00 grant from the University of Cincinnati.

Summary

We anticipate starting this initiative during the fall of 2002. All the students will receive their degrees from their home institutions. At the completion of their senior capstone projects, students normally acquire the following necessary skills, which they apply in their professional careers.

Synthesizing knowledge from earlier courses
Going from concept to a working prototype
Project Management
Time Management
Dealing with Vendors
Oral communication to a technical audience
Writing a formal project report

The students and the faculty advisors participating in International Senior Capstone Project will acquire following additional skills.

Teamwork
Working on an Industrial Project
Working with a multi national corp.
Familiarization with diverse design, manufacturing and testing environments
Working with members of diverse cultural backgrounds
Living in a foreign country
Using Modern Technology for Distance Communication

It is envisioned that the initiative will be expanded to include more institutions and more countries from other regions of the world.

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Biographies

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Muthar Al-Ubaidi is an Associate Professor in the department of Mechanical Engineering Technology at the University of Cincinnati. He received his BSME from the University of Baghdad, Iraq, his MS in Nuclear Engineering from the University of London, UK and his PhD in Nuclear Engineering from the University of Cincinnati. He has served as the program chair and chair of the International Division of ASEE and is again serving as chair for the International Division. He is the chair of the Interamerican Council for Engineering and Technology education. Presented papers in national and international conferences.