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Vertically Integrating Mechatronics Education at Virginia Tech

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BACKGROUND:

The advent of more complex mechatronic systems in industry has introduced new opportunities for entry-level and practicing engineers. Today, a select group of engineers are reaching out to be more knowledgeable in a wide variety of technical areas, both mechanical and electrical. A new curriculum in mechatronics developed at Virginia Tech is starting to bring students from both the mechanical and electrical engineering departments together, providing them with an integrated perspective on electromechanical technologies and design. The course is cross-listed and team-taught by faculty from both departments. Students from different majors are grouped together throughout the course, each group containing at least one mechanical and one electrical engineering student. This gives group members the ability to learn from one another while working on labs and projects. **This proposal suggests additional improvements for the mechatronics course, leading to a vertical integration framework that provides new opportunities for second-year students who are motivated by the interdisciplinary, design-oriented curriculum of mechatronics.**

PROPOSED PROJECT:

Mechatronics education is by its very nature an interdisciplinary, integrating experience for engineers of many disciplines. Today, mechatronics education in the United States is gaining widespread acceptance by university faculty, industry, and students who wish to make themselves more versatile in a new engineering environment brought about by a digital revolution. The Virginia Tech PI's for this proposal have already designed a senior-level, technical elective course in mechatronics. The effort was funded in part by the NSF SUCCEED project, for the development of a special purpose website used to guide the students through a series of laboratory projects. The lab projects are based on the construction and use of a special-purpose microcontroller prototyping board (www.mechatronics.me.vt.edu). Those projects require that students master detailed assembly-level programming skills – a challenge for seniors who do not have very much experience in real-time programming.

This proposal is submitted to meet a need to begin a framework for vertical integration in the mechatronics curriculum, where second-year students (from the Mechanical Engineering department) are given the opportunity to participate in mechatronics laboratory exercises and design projects. The work tasks for this project will develop a web site that offers a series of special programming tasks that a limited number of second-year students will conduct with occasional supervision from a graduate teaching assistant and the course instructors. The students who will participate in this vertical integration will be selected from students in the ME 2024 Design course. During that course, the students become members of design teams created during the semester. These students are required to follow specific design methodology as they complete a half-semester project. This vertical integration project will be merged with the ME 2024 design project through a special purpose website that relies on existing features from the previously sponsored mechatronics website, as well as new information that integrates the design methodology with the mechatronics approach to smart product design.

The principal investigators believe that there are numerous benefits that will result from this new project for vertical integration. Younger students will certainly benefit from mentoring that will occur in the mechatronics laboratory setting, mostly by fourth-year peer students. It will also be beneficial, for the next several years, to have web-based, simpler, special programming assignments available even for a number of fourth-year students who are taking the class for credit. There are usually a number of students, mostly mechanical engineering students, who have some difficulty with the assembly programming requirements. It will be helpful for them to complete these additional assignments (not for credit). Most importantly, this project may be used as a starting point for the development of a *mechatronics track* through the curriculum for both mechanical and electrical/computer engineering students. Details of a specific mechatronics 'track' , whereby students select their technical and free electives to coincide with goals for mechatronics education, are currently being considered by the principal investigators. One emphasis of such a track would be on the application of real-time programming skills at the second-year level. Therefore, this project will naturally facilitate a more expansive, track-oriented approach to vertical integration in the next couple of years.

WORK TASKS:

Beginning in the first summer semester, 1999, the PI's will initiate the design and construction of a website that will guide the vertical integration project. Professor Don Leo, who was instrumental in the development and instruction of ME 2024 during its first year, will be a principal investigator on the project. Don will be responsible for ensuring that the design methodology is adequately integrated with the technical aspects of the smart product design. The students will be given access to a special purpose, blackbox prototyping system that contains one or two VT84 boards that deliver seamless signal input and actuator output, along with a user-friendly environment for programming using higher-level software. The website will present technical details about how to use the blackbox to prototype various smart product design concepts. In addition, detailed programming modules will be offered to students who wish to accelerate their skills in this area. Dr. Saunders and Dr. Bay will be responsible for the detailed VT84 instructions built into the website and Dr. Saunders will coordinate the website development.

During the Fall 1999 semester, the PI's will guide the ME 2024 student design teams as they learn how to use the VT84 board for smart product design. Dr. Leo will be the essential link to the ME 2024 student teams and Dr. Saunders, an instructor in ME 4734 Mechatronics, will coordinate the vertical integration within the mechatronics laboratory environment. The smart product design goals will be dictated by the ME 2024 course objectives; a final presentation of the design results will be presented in that classroom setting and will be posted on the vertical integration website.

MILESTONES:

Summer 1999	Fall 1999	Summer 2000	Fall-Summer 2000
Initial Website for ME2024-Mechatronics Vertical Integration Project to be Designed and Constructed. VT84 blackbox prototyping system designed and completed.	Initial Testing of the Smart Product Design Vertical Integration Concept via blackbox device and Website..	Refinement of Website Based on Assessments .	Final Testing of the Vertical Integration Concept via Website Studies.

The last year of the Vertical Integration Project will focus on the inclusion of EcpE students and development of a Mechatronics Track through the two curricula.

DELIVERABLES:

The deliverables for this project will be a special-purpose, instructional website that is used to promote vertical integration of second-year engineering students from the Department of Mechanical Engineering and the Department of Electrical and Computer Engineering. In addition, the assessment information and overall success of the vertical integration framework will be reported at an educational conference sometime in the year 2001.

PROPOSED BUDGET ITEMS:

Completion of the special-purpose programming exercises will require dedicated time from the PI's, time from a graduate assistant, and a small budget for extra materials/supplies to accommodate the additional numbers of students in the mechatronics laboratory. The list below shows the details of these needs.

- Graduate assistant for the second summer session in 1999, website design and construction.
- Graduate assistant for the Fall and Spring semesters, 1999-2000 academic year.
- Summer support for faculty (approximately two man-months).
- Six VT84 boards, assembled ($400).
- One pentium PC computer ($1,500)
- Misc. supplies ($300)

The NSF SUCCEED program has previously provided approximately $20,000 of funding to support the development of a special purpose 'how-to' website for mechatronics at Virginia Tech and an additional website that instructs other faculty members how to develop these kinds of 'how-to' websites. The mechatronics website is now serving as the model for mechatronics programs at Cooper Union, Bucknell, Univ of Mass at Amherst, and is being considered by the Bochum Polytechnic Inst. in Bochum Germany.