**Provo's Learning Innovations Grant for Faculty**
**Request for Full Proposal**
**2002-2003**

Please send your completed grant proposal (4 pages, plus attachments), one original and eleven copies, to Linda Jones, 4000 Eastman
by 4:30 p.m.
Wednesday, February 20, 2002.
No hand written proposals will be accepted.
Notification of awards will be made by Friday, March 22, 2002.

**Project Title: Update and Upgrade of Microcomputer Laboratory Equipment**

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1. Update and upgrade of Microcomputer Laboratory Equipment

The focus of this proposal is the integration and development of laboratory exercises associated with Microprocessor Evaluation boards utilized in fundamental Microcomputer courses taught by the Department of Electrical Engineering. This will serve to update the technology the students have access to as well as provide a suitable platform for more advanced course work in the area of microprocessors, embedded microprocessor design and microprocessor software design.

Currently, the introductory microcomputer course utilizes a relatively simple and somewhat dated microprocessor evaluation board (Anewsh SBC68K, Motorola 68000 Processor, 1990) that illustrates fundamental microcomputer concepts via a series of simple laboratory experiments. Unfortunately, it does not provide a platform that meets the requirements for more advanced elective course work in the area of microprocessor development offered at both the undergraduate and graduate level.

We have identified and obtained a complement of 20 state of the art microprocessor evaluation boards that employ up-to-date technology in terms of the processor architecture and integration of peripheral devices (Matrix M5307C3, Motorola Coldfire Processor, 2001). This microcomputer system utilizes a descendant of the 68000 microprocessor currently employed on the current microprocessor boards. As such, there is a great deal of compatibility in the native assembly language used to program the respective microprocessors. This is of great benefit in transitioning to the new hardware as a large part of the Introduction to Microcomputers course focuses on programming in native assembly language.

We believe that these boards will provide a suitable platform for the introductory course work as well as for advanced courses associated with microprocessor based systems. The fundamental course entitled Introduction to Microcomputers is a core requirement of the undergraduate Electrical Engineering curriculum. There are a number of advanced undergraduate and graduate courses that focus on microprocessor based system design (32-bit Microprocessors, Embedded Microcontroller Design, Advanced Software Design for Microprocessors). By choosing a microprocessor system with advanced capabilities, it will be possible for the student taking one of these advanced courses to leverage the knowledge and experience gained in the Introduction to Microcomputer course. This will facilitate focusing on the concepts associated with utilizing a microprocessor based system in these advanced courses without necessarily having to become familiar with a new architecture at the outset of each course.

The boards we have obtained are of commercial quality and as such require some integration and development effort, both in terms of software and peripheral hardware to be properly utilized in an academic setting. A graduate student under the guidance of the faculty members mentioned will carry out this work. The faculty members will be responsible for incorporation of the board in the associated courses in which they will be used. The majority of this proposal involves the costs associated with salary support for the graduate student for one quarter. Approximately 30% of the budget request is allocated to the hardware necessary for assembling suitable laboratory setups that incorporate the new board.

This development effort consists of two parts: design of a suitable hardware interface and development of laboratory experiments that incorporate a suitable software development environment. The hardware interface has already been designed and prototyped. It provides a flexible user interface consisting of toggle switches, a hexadecimal input keypad, individual light
emitting diodes (LEDs), four seven-segment light emitting diode displays and a multi-line liquid crystal display (LCD). The hexadecimal input keypad and the LCD are interfaced to the microcomputer via a serial interface. A suitable software environment has been identified and a budget request submitted. Revision to current laboratory experiments to take advantage of the enhanced capabilities of this microcomputer system are currently in progress.

2. Targeted learners or population
   (include cluster, departments, year level, number of learners impacted).

The Introduction to Microcomputers course is currently offered twice an academic year in the Winter and Spring quarters. The enrollment varies from 40 students in the Winter quarter to 60 students in the Spring quarter. The course has a required laboratory component in which there are multiple sessions consisting of 16 students and a Technical Assistant. The advanced courses in microprocessor related content typically are offered at least once a year with enrollments typically varying from 16 to 32 students per quarter.

The initial target population is the second year undergraduate Electrical Engineering students for whom the Introduction to Microcomputers is a requirement. The secondary target population consists of upper level undergraduates and graduate students. It is also anticipated that this updated microcomputer system board will also present a useful opportunity for incorporation into a number of senior design projects that are also a curriculum requirement.

3. Anticipated impact on teaching and/or learning.

The anticipated impact on teaching will be derived from the integration of a state of the art microprocessor based system into the current Electrical Engineering curriculum that is similar to what one would encounter in a typical engineering design environment. This allows incorporation of material that addresses "real-world" design issues. It also provides the opportunity for the associated faculty to stay current with the available technology and innovations in this area of electrical engineering. There is an additional motivational benefit for both teaching and learning that is derived from the students having a sense of working with a system and its associated development tools that they will be likely to encounter in the work place during their cooperative education employment or after graduation.

As mentioned above, by providing a platform that can be incorporated into a range of courses associated with microprocessor-based design, there is a leverage that can be obtained both by faculty and students. The faculty can develop courses that build on previous knowledge and experience with a given development environment. This type of continuum also facilitates the learning process for the student by allowing them to investigate and understand increasingly more sophisticated and complex aspects of microprocessor based design with a common hardware platform.

4. How you will measure the impact, how you will report your findings, and what you will share about your project in a faculty forum.

The procedure by which the implementation will be evaluated will be assessment: a) of its success in being incorporated as a replacement for the current laboratory equipment in the Microcomputer Fundamentals course work by standard student evaluation and b) by faculty conducting the course in terms of its usefulness in illustrating the concepts presented in class. This type of assessment will also be carried out in those advanced courses where it is adopted
for use (Microcontroller Embedded System Design, 32-Bit Microcomputer Systems, Advanced Microprocessor Software Design) as well as investigating its applicability in other courses whose focus is not microprocessor technology directly but that incorporate some type of microprocessor based system in terms of implementation or demonstration of course principles (e.g., Design of Digital Control Systems).

Findings from the above assessments will be incorporated in a report to be circulated among the faculty of the Electrical Engineering department. Progress in development and utilization will also be relayed to the Electrical Engineering faculty in the form of a presentation given as part of an on-going series of lectures given by faculty members on their research and development efforts.

The information provided will consist of two parts: efficacy of hardware in augmenting illustration and understanding of salient course topics from a teaching perspective and from a learning perspective. The teaching perspective will involve documentation of changes and improvements in course presentation and laboratory exercises that are made possible. Documentation of learning improvements and suggestions will be made based on feedback from the students via a survey presented at the completion of the respective courses in which it is used.

5. **Present a rationale for your project, as it ties to the intent of the grant, including:**
   a. **why it is not part of regular college business**

   Typically, laboratory equipment and systems are purchased as turnkey entities, specifically configured for an "academic" environment. Unfortunately, this approach can result in educational experiences that are somewhat "artificial" in nature. Students, especially those who have had some type of exposure to commercial development tools in a cooperative employment situation, can easily sense this. What we are advocating is utilizing a commercially available tool and providing a suitable interface that allows it to be incorporated into an academic environment. This involves participation by faculty and students to develop the requisite hardware and software capabilities.

   b. **its relevance to required cluster, college, and/or department competencies**

   As stated above, the microcomputer system will be used as part of a mandatory component of the Electrical Engineering curriculum and as a pathway for advanced development in other microprocessor based courses offered by the department.

   c. **describe how your project is relevant to other faculty and what you think it would take to transfer your success to other faculty**

   There are a number of faculty who are involved with courses that have a component associated with the utilization of microprocessors for a variety of systems. The success in this endeavor can be transferred to other faculty via the laboratory experimental procedures that are developed as well as the documentation associated with the utilization of the additional hardware and software being proposed.

   d. **relevant credentials, experience of involved faculty/staff**

   D. Phillips has over 20 years of both industrial and research experience associated with functional test and data acquisition associated with microprocessor based systems. At the end of the spring quarter of this year, he will have taught 5 sections of the Introduction to Microcomputers course over the past year as well as teaching and revising the course in Advanced Software Design for Microprocessors. P. Reddy holds positions in both the Electrical Engineering and Computer Engineering departments and has over 30 years of both industrial and academic experience in the area of digital systems and design. He has conducted courses in a wide variety of topics related to
digital systems, digital test and microprocessor-based systems. F. Sahin received his B.Sc. in Electronics and Communications Engineering from Istanbul Technical University, Turkey, in 1992. He received his M.Sc. and Ph.D. in Electrical Engineering from Virginia Polytechnic Institute and State University in 1997 and 2000, respectively. His thesis included a Radial Basis Functions Networks solution to a real-time color image classification problem. During his Ph.D. studies, he performed research in biological decision-theoretic intelligent agent design and its application on mobile robots in the context of distributed multi-agent systems. In September 2000, he joined the Rochester Institute of Technology, where he works as an assistant Professor. His current fields of interests are mobile robots, autonomous robots, navigation, intelligent control, nonlinear control, multi-agent systems, decision theory, artificial immune systems, and bio-robotics. He is a member of the IEEE Robotics and Automation Society, Computer Society, Systems, Man, and Cybernetics Society, and the American Association for Engineering Education (ASEE). He has conducted courses in Robotics, Computer Architecture and Data Structures, Digital Systems and programming courses in C and C++.

e. Describe how this is an innovation in your discipline or program
There are two aspects of the innovation inherent in the proposed work. First, as mentioned above, it involves adapting commercially available evaluation tools for suitable utilization in an academic environment. Second, there is a strong component of undergraduate and graduate student participation in the process of development. This offers a number of advantages to both the faculty and the students. The students provide the faculty with a measure of perspective in terms of the student’s perception of the relevance and motivation of the tools and environment being developed. In turn, the student gains insight into the considerations necessary to implement a successful system design in terms of its functionality and applicability for an educational environment.

6. Provide a timetable of the development of the project.
As mentioned above, the microprocessor evaluation boards have been purchased and received by the Electrical Engineering department. A prototype hardware interface has been designed, prototyped and is in the process of verification. Development of new laboratory experiments and revision of current experimental procedures is currently under way as is evaluation of a suitable software environment. We anticipate fabrication and debugging of the necessary hardware interface will be accomplished during the Spring 2002 quarter of this academic year. Revision and adaptation of this system into the Introduction to Microcomputers and Advanced Software Design for Microprocessors courses will take place over the course of the Summer 2002 and Fall 2002 quarters. This will include participation by an upper level undergraduate student as an independent study project. The system will be incorporated into course offerings for the Winter and Spring quarters of the 2002/2003 academic year. A report that incorporates faculty observations and findings as well as student feedback will be compiled at the completion of the Spring 2003 quarter.
Grant Application Budget 2002

Funds can be used for release time, student workers, and for purchasing supplies and services (such as CD pressing, video production, digitizing, photography). Funds will generally not be available for activities consistent with normal college business, doctoral research, equipment purchase or travel (though the latter will be considered if a clear connection can be demonstrated between the project and a given conference or workshop).

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<th>Start Date - April 1, 2002</th>
<th>Total Amount</th>
<th>Budget Officer Verification</th>
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<td>End Date - June 30, 2002</td>
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**SALARIES:**

- **Faculty Compensation:**
  - (College guidelines for adjunct teaching)
  - Pay-scale should be used.
  - 2
  - 3
  - 4

  If you are requesting adjunct faculty money, include 8% of the salary dollars requested to cover the associated benefits.

- If you or another full-time faculty or staff member will be paid from the grant, the rate is 22.8% for benefits.

- **Student Assistants:**
  - $3,750
  - 3 months of support at a rate of $1,250/month

- **Other:**
  - (Professional services, consultant, staff support)
  - 0

**SALARIES TOTAL**

**MATERIALS:**

- Electronic parts, wiring and mounting hardware for assembly of user interface ($200 per interface, 1 interface/board, 20 boards)
  - $4,000

**MATERIALS TOTAL**

**SERVICES:**

- Attach appropriate estimates
- **Educational Technology Center:**
- **Other:**
  - (Describe)

**SERVICES TOTAL**

**TOTAL BUDGET REQUEST**

**COLLEGE SUPPORT:**

- Support provided by college in addition to grant request, if applicable.
- 20 mezzanine space evaluation boards (already purchased)
- One quarter of graduate tuition support ($587/credit hour * 8 credit hours)

**Signatures:**

- [Signature]

- RJB 2/20/02