

## **The Evergreen State College**

### **Integrating Recent Research Results into an Interdisciplinary Undergraduate Curriculum**

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#### **1. Overview of Goals and Objectives**

The Evergreen State College, Oregon Graduate Institute (OGI) and the Washington Center are collaborating to integrate recent computer science research into an upper division interdisciplinary undergraduate curriculum. Evergreen is a public four-year liberal arts college with a proven record in curricular innovation and the Washington Center is a state-supported institute located on the Evergreen campus whose mission is promoting low-cost, high-yield approaches to educational reform. OGI is a private graduate-only research institution with a reputation for research excellence.

We selected three research areas where OGI is particularly active and where Evergreen faculty have strong interest: software engineering of scientific systems; formal methods and higher order logics; and neural networks particularly applied to speech recognition. Our focus has been on developing materials and a model for non-Ph.D. granting, primarily undergraduate institutions where faculty often teach courses (even upper division courses) not in their own sub-field.

We believe that integrating research results into the curriculum will have a number of benefits.

1. It will invigorate faculty not at research institutions.
2. It will attract students to the field, prepare them for a career of change, and encourage some for graduate school.
3. It will broaden computer science as currently conceived and taught at the undergraduate level (perhaps opening the computing culture to underrepresented groups). Moreover, exposing students to research is a necessary part of educating and training them in the process of software development.

We further believe that the teaching of research to undergraduates can be as effectively accomplished by expert teachers as by the researchers themselves. To succeed in developing materials that successfully integrate research results,

however, faculty at non-research institutions must develop ties to a research institution. Once curricular enhancements are established, materials can be disseminated and sustained by links among undergraduate teachers at the regional level. Although the innovative year-long, team-taught teaching model used at Evergreen may be particularly fertile ground for developing and testing teaching materials, materials we develop can also be integrated into more traditional curricula.

Our objective has been to figure out ways to "broker" regional research that holds promise by

1. establishing working relationships between undergraduate faculty at Evergreen and researchers at OGI,
2. developing materials in three target disciplines that could be integrated into an existing curriculum without adding additional courses,
3. articulating teaching modes particularly suitable for conveying research results,
4. establishing contacts with regional educational institutions, employers of our graduates, and the graduates themselves to enhance, disseminate, evaluate and sustain our efforts, and
5. developing a model for non-Ph.D. granting institutions to initiate programs of excellence in advanced computer science.

## 2. Current Status and Accomplishments

Since September 1994 four Evergreen faculty have spent at least one quarter at OGI studying research results in the targeted fields of formal methods, neural nets applied to speech recognition and multi-modal human interfaces. In the summer of 1996, we conducted a regional workshop for undergraduate faculty (see Dissemination Activities, below), and a similar national workshop will be conducted this summer.

Research materials are being integrated into three Evergreen programs:

- (1) Student Originated Software. This year-long, full-time upper division program intends to provide students with the skills and in-depth practical experience necessary for working in a team that plans, manages, designs, implements and deploys a major software project. It aims to offer a sound basis in the theory and practice of advanced computer science topics and to maintain contact with software engineering efforts in the Seattle-Portland area.

Software development is taught via a quarter long case-study, a six month group project, and seminars on design and methodology. The grant allowed for several innovations to this program in 1995-1996 (with more planned for use in 1997-1998). Among the innovations were:

- A quarter-long case study in software engineering that included materials in object-oriented design and programming.
- A follow-on quarter-long seminar on (object-oriented) design patterns.
- A 2-credit seminar on recent human factors research.
- A 2.5 hour workshop on software risk.
- Several projects involving scientific databases and visualization research: ecological databases to support collaborative research, genetic database mining, computational chemistry workbench beta testing, scientific collaborative software, network security. Two of these projects were carried out for customers at the Environmental and Molecular Sciences Laboratory of Battelle Pacific Northwest National Laboratory (PNNL); others for Jet Propulsion Laboratory, the Wind River Canopy Crane Research Facility, and Cold Spring Harbor Laboratory. The PNNL effort resulted in four students and two faculty receiving summer fellowships to continue the work at PNNL. A PNNL regional collaboratory for scientific education is being launched with Evergreen as a key player, as well as Reed College and the University of Washington.

- (2) Data to Information. This year-long, full-time introductory program, team-taught by a computer scientist and a mathematician, contains some upper division content. It is aimed at second-year computer science majors, or other students who want to prepare a minor in computer science. An unanticipated accomplishment of the grant has been an experiment (in 1995-96) of integrating the teaching of discrete math and programming through the use of the functional programming language ML into this program.

- (3) Computability and Cognition. This year-long, full-time program is an integrated course of study in computer science, mathematics, philosophy and cognitive science. It emphasizes the nature of formal systems -- their power and limitations, including challenges to symbolic approaches in artificial intelligence, especially those emanating from connectionist computational models. Students follow rigorous study of discrete mathematics, formal logic, logic programming, automata theory, computability theory, connectionist computational models, with integrative seminars in the philosophy of mathematics, language and cognitive science. An advanced functional programming course this spring will integrate notions of formal specifications derived from Evergreen faculty experience at OGI. A several-week workshop in prototyping spoken user interfaces will beta-test software and prototyping methods developed at OGI, and illustrate a practical use of neural nets.

In addition to the above curricular accomplishments, seven UNIX workstations with software environments mimicking the research environment at OGI have been installed for Evergreen faculty, and the Evergreen teaching lab is now equipped to run either Windows or LINUX. The PI Judy Cushing (largely as a result of her work on this grant) has been selected as a member of the board of a state-wide

effort to coordinate effective information technology education at the high school, community college and four-year college levels.

### **3. Plans for Remainder of Project.**

- (1) We will send two more faculty during the current academic year to OGI to work in the areas of functional languages or multimodal user interfaces, object databases and domain specific languages. The emerging IEEE standard for object-oriented design (IDEF1X) will be tested and integrated next year into our curriculum, as joint work with one of the committee members and OGI faculty.
- (2) We have begun work on web pages describing the above programs.
- (3) Data to Information faculty are writing a paper describing the introductory ML programming course experiment integrating mathematics with programming.
- (4) We plan to polish and publish on the web and elsewhere course materials.
- (5) We plan a second week-long national summer workshop for 1997.

### **4. Materials Developed**

Materials Developed include teaching materials (workshops and syllabi) for the three programs discussed above, and a proceedings of the summer workshop that included curricular materials developed there. One faculty is working on a textbook. Two faculty have written papers jointly with OGI researchers.

### **5. Dissemination Activities.**

Our primary activity was a regional workshop "Curricular Innovations to Promote Software Skills" in the summer of 1996; this was attended by 28 undergraduate faculty, 9 researchers presenting their work, 10 industry and government participants, and 7 recent graduates of regional institutions. Follow-up activities for the Summer Workshop were proposed by participants, and include: regional efforts for bringing undergraduates for a day at "graduate school" and for innovating computer graphics teaching. PI Cushing has also been asked to present curricular material at University of Oregon.

Evaluation Activities. We are just launching a formal evaluation (by an external evaluator) of our work. Evergreen faculty write extensive self evaluations, and students in each of the above programs wrote narrative evaluations of faculty. Participants in the summer workshop filled out evaluation forms. Several industry representatives have evaluated the project work in Student Originated Software.

Benefits Seen and Expected. The grant has had a tremendously successful rejuvenating effect on participating Evergreen faculty. Their time at OGI working with researchers has resulted in several successful opportunities for Evergreen faculty, for example: two co-authored papers, a successful NSF biological database grant, a jointly sponsored ML summer school in 1996, and joint sponsorship of the 1997 international scientific and statistical database workshop. Students graduating from the Student Originated Software program have received noticeably (about \$10,000) higher starting salaries. This program was selected as a model for innovation and entrepreneurship in education by the Lemelson Foundation, and was awarded over \$25,000 to support student projects. The Student Originated Software project work with PNNL resulted in coveted summer fellowships to Evergreen faculty and students, and our inclusion as a key player in the PNNL regional laboratory.