Software Engineering Education via the Use of Corporate-Sponsored Projects: A Panel Discussion of the Approaches, Benefits, and Challenges for Industry-Academic Collaboration

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Abstract

In this panel, we will address questions regarding the development and execution of one type of industry-academic collaboration – corporate-sponsored projects. As representatives of programs at both public and private institutions, we will address a set of questions related to these programs. We have prepared an initial list that will be augmented with questions submitted and voted on by conference participants in advance of the session. After we have presented our prepared responses, the balance of the session will be dedicated to open discussion with audience members.

1. Panel description

The education and training of today's software engineering students has moved out of the traditional classroom. Textbooks and lectures can teach about the best practices of software engineering, however, our students can benefit greatly from practical experience. We have assembled a faculty panel with a combined total of 46 years of experience with corporate-sponsored projects courses of various kinds. Our experiences can help you in the development and execution of your own projects course, by providing insights into various approaches, potential benefits, and common challenges. Rather than a series of descriptions of existing efforts, our presentation will be structured as responses to a list of questions prepared in advance by panel organizers and conference participants, prioritized by participant voting.

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Sample questions include:

- What are the benefits to the corporate sponsors?
- How do you find corporate sponsors?
- Who can propose a project?
- How does a corporation propose a project?
- How are the intellectual property and proprietary information handled?
- What are the responsibilities and commitments as a corporate sponsor?
- Do you charge sponsors for a project? If so, how much?
- Do corporate sponsors expect that projects be closely related to their product development or research?
- What are the size, scope, and duration of a project?
- How do you scope a project?
- What are the benefits to the students?
- How are students assigned to projects?
- What are the prerequisites for the project course?

2. Panel biographical information and position statements

2.1. Geoff Kuenning

2.1.1. Biographical information: Geoff Kuenning is a professor in the CS Department at Harvey Mudd College in Claremont, California, where he directs the Computer Science Clinic program. Prior to joining Mudd 15 years ago, he spent over 20 years working in various industrial positions. He is a member of ACM, IEEE, and Usenix, and SNIA, and co-chairs the SNIA IOTTA Technical Working Group. His primary research interests are in file systems, storage systems, and performance analysis.

2.1.2. Position statement: The Clinic program at Harvey Mudd College (named by analogy to medical training clinics) is celebrating its 50th anniversary, with nearly 1400 projects completed. The program spans the Computer Science, Engineering, Mathematics, and Physics departments, executing about 40 projects annually. In 2012, three of the program's founders were awarded the National Academy of Engineering's Bernard M. Gordon Prize for Innovation in Engineering and Technology Education in recognition of the program's achievements.

All students in the CS and Engineering departments are required to enroll in Clinic as a capstone experience; in Mathematics and Physics they can alternatively choose a thesis option. The College charges a fixed fee, which covers all costs, and returns all intellectual property to the sponsor. Students are assigned in teams of 4-5, with a faculty advisor and sponsor liaison for each. Clinic is treated as a for-credit course that spans an entire academic year. The faculty advisor does not participate in the work; the students must plan and execute the project with minimal guidance. A number of deliverables are required during the year to ensure that the program's educational goals are met; these include a design review, multiple presentations, sponsor site visits, a poster, written documents and reports, and final code delivery.

The program is administered by a faculty Clinic Director in each department, administrative support staff, and a college-wide Director of Corporate Relations who helps locate potential sponsors. The costs of these positions are paid from the fixed Clinic fee. The Clinic Directors are responsible for choosing projects, scoping them, and arranging cross-disciplinary teams.

As befits a program with such a long history, Clinic has a strong track record. Employers and graduate schools often comment that the Clinic experience makes Harvey Mudd graduates desirable, and many sponsors return multiple times; the record-holder has sponsored over 80 projects.

2.2. Mark Sebern

2.2.1. Biographical information: Mark Sebern is a professor in the EECS Department at the Milwaukee School of Engineering (MSOE), which he joined after twenty years in industry practice, and founding program director of MSOE's undergraduate software engineering (SE) program, which produced its first graduates in 2002. He is a member of the ABET Engineering Accreditation Commission, the CSAB Board, and the task force charged with revision of the ACM/IEEE-CS SE2004 SE curriculum guidelines.

2.2.2. Position statement: The BSSE curriculum at MSOE has, since its inception, incorporated two yearlong project experiences. The first, a software development laboratory sequence beginning in the third year, involves only SE students, who work in moderately large, 5-6 member teams on projects that usually last long enough to involve more than one student cohort, and thus require transitions from one team to the next. The second experience, a senior capstone project, is often interdisciplinary in nature. Corporate sponsors can support and act as stakeholders for projects in both venues, though not all projects are required to have such sponsorship. Corporate sponsors often have ongoing relationships with the software engineering program, such as service on its industry advisory committee, participation in and support of student technical and social events, and recruiting of interns and graduates.

Faculty, students, or sponsors may initiate projects. There are no fixed sponsorship fees, but sponsors typically provide or fund project materials and equipment. Sponsor expectations must be managed to reflect the fact that students are not able to devote full time to project work, and sponsor representatives must commit to ongoing communication and periodic face-to-face meetings. As projects progress, students are responsible for all project activities, applying knowledge and skill in requirements analysis, architecture and design, implementation, verification, team self-management, and stakeholder communication. Full-time faculty members are assigned as project advisors, and meet with student teams at least weekly, more often in the software development laboratory sequence. When necessary, non-disclosure agreements and other forms of intellectual property protection are negotiated. Project teams have dedicated workspaces and shared meeting spaces.

2.3. James Vallino

2.3.1. Biographical information: James Vallino is the Chair of the Department of Software Engineering at Rochester Institute of Technology (RIT). His career spans more than 35 years equally divided between industrial work on hardware and software development, and academic work developing the first undergraduate degree program in software engineering in the United States. During his time in industry, he has worked for AT&T Bell Laboratories, AVL and Siemens Corporate Research in

telecommunications, factory automation, medical imaging, computer graphics, and semiconductor processing. On the academic side, he is interested in real-time and embedded systems, software design particularly design patterns, and software engineering pedagogy. In 2002, he initiated the move to active learning and problem-based learning that is used in all of RIT's software engineering courses. His teaching has been honored by his receiving a 2010 RIT Eisenhart Award for Outstanding Teaching. Dr. Vallino holds a BE in Mechanical Engineering from Cooper Union, an MS in Electrical and Computer Engineering from the University of Wisconsin – Madison, and an MS and PhD in Computer Science from the University of Rochester.

2.3.2. Position statement: There is no question in my mind that incorporating external sponsors into class project activity pays enormous benefits to the students, and is well worth the effort required, and it is a non-trivial effort. There are many ways in which industry, or more broadly external, collaboration can be a part of an undergraduate computing program. The one which is perhaps most common, and which the software engineering program at RIT is most experienced, is externally sponsored capstone projects. The capstone project is a hallmark of engineering education, and has been getting adopted in a growing number of other disciplines. Our two-term senior projects have used 100% external, to the department, sponsorship since our first graduating class in 2001. With the current cycle of projects, we will have experience with over 120 projects for more than 70 sponsors. Our sponsors are corporations, non-profits, government agencies, and non-software engineering RIT sponsors.

A program interested in starting to work with sponsors for their course projects will need to sort out several issues that are related directly to sponsorship, and somewhat independent of the decisions you will make about course syllabus, curriculum, grading, etc. The sponsor-related issues include, but are not limited to, the following questions: who can sponsor a project, how do you attract project sponsors, what guidance do you provide to sponsors regarding project size and scope, can any part of the project deal with proprietary information, what commitments do you expect from the sponsor, what will be promised as deliverables to the sponsors and how can they use it, and are the sponsors charged for participation.

Addressing the sponsorship issues will be an evolutionary process that needs to be tailored to your particular program and institution. At RIT, we have aimed to make sponsorship of a senior project as easy as possible. To that end, the project proposal form is not onerous to complete, we do not charge the sponsor any fees, the students—who own everything they do as part of coursework—assign rights to the entire project to the sponsor, and the students and faculty coach sign non-disclosure agreements that provide a mechanism for some part of the project to deal with proprietary information. In return, throughout the project, we require a fairly high level of project sponsor involvement with weekly meetings, and between meeting responses to questions or the review of artifacts. This approach has been very successful, each year yielding many more project proposals than we will have teams to work on them, and delivering working prototypes, or sometimes very close to production deliverables.

2.4. Linda Werner

2.4.1. Biographical information: Linda Werner is an Adjunct Professor of Computer Science in the Jack Baskin School of Engineering at the University of California, Santa Cruz (UCSC), where she has developed and taught software engineering courses since 1985 and is affiliated with their Corporate Sponsored Senior Projects Program. Dr. Werner was the PI on an NSF-funded project on the retention of female students in computer science where her study of the use of pair programming in introductory computer programming courses is considered one of the most extensive studies of pair programming in educational settings,

producing findings that motivated NCWIT to list pair programming as a 'best practice.' In addition, she has many years of experience as a software engineer. She is currently involved in research in game design as a strategy for increasing girls' and other underrepresented minorities' interest, skills, and confidence in technology; computational thinking and what it means for the middle school-aged student; and the study of computer science students in community colleges looking at the role of motivation, family support and prior computer use. Dr. Werner has a BA in Mathematics from Clark University, and an MS and Ph.D. in Computer Science from the University of California, San Diego. She is an affiliate of the Center for Games and Playable Media and the Center for Information Technology Research in the Interest of Society both at UCSC.

2.5. W. Eric Wong

2.5.1. Biographical information: W. Eric Wong received his B.S. in Computer Science from Eastern Michigan University, and his M.S. and Ph.D. in Computer Science from Purdue University. He also received a certificate from the Georgia Tech Mid-Management Certified Program in 2001. In addition, he was a member of the Telcordia PDP Class of 2000, a two-year leadership development program offered to a limited number of selected employees of Telcordia Technologies (formerly Bellcore or Bell Communications Research).

Currently, Dr. Wong is a Professor and Director of International Outreach in Computer Science at the University of Texas at Dallas (UTD) where he is also the Group Leader for the Software Engineering Group. Dr. Wong also has an appointment as a Guest Researcher from NIST (National Institute of Standards and Technology), an agency of the U.S. Department of Commerce, located in Gaithersburg, Maryland. Before joining UTD in 2002, he was with Telcordia Technologies as a Senior Research Scientist in Applied Research and a project manager under the Horizon Research Program. Dr. Wong is the Vice President of the IEEE Reliability Society and the Secretary of the ACM SIGAPP (Special Interest Group on Applied Computing). He is also the founder and Steering Committee Chair of the IEEE International Conference on Software Security and Reliability (SERE).

2.5.2. Position statement: Selecting a suitable project for students is never an easy task for instructors because there are several constraints and conditions that must be kept in mind including the following:

- The project must be related to the course content.
- The amount of time students are expected to spend on the project should be reasonable.
- The project completion by the students in the allotted time should be feasible.
- The students must be adequately prepared to successfully complete the project.
- The project must be designed such that it aims to be fair to all of the students in the class.

Even when a project satisfying such conditions is proposed, a common complaint is that it does not represent real-life software or is too simplistic. We will share our experiences of bringing in industry partners to not only help propose projects but also evaluate the outcome for a capstone software engineering project course. Such collaboration between industry and academia has been very well received by the students and faculty at UTD and our industry partner alike.