

Cooperatively Enriching Education: Industrial Projects for Academic Credit

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Abstract

Industry and universities have long worked together on cooperative education (co-op) projects in which a student spends a semester or more working in industry. Could even shorter-term projects be of mutual benefit? During the Spring 2001 semester, NCSU and the IBM Smalltalk Group set up a program where an NCSU faculty member and IBM employees jointly supervised students working on small, well-defined Smalltalk projects for academic credit. Benefits to the students included gaining experience on a real-world software project directly related to their coursework, and making valuable contacts in industry. Benefits to the NCSU Computer Science department included offering its students the ability to work with practicing software developers in a small-group setting. For its part, IBM obtained short-term help on three projects, and acquaintance with several potential job candidates.

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1. Genesis of the Project

IBM has a longstanding intern/co-op program, which brings in students to work as part of product teams. Many other companies have similar programs. The IBM Smalltalk Group (STG) has one or two intern/co-op students working with the group at any given time. The goal of this program is to provide the students with valuable work experience in an industry area of their interest. The program also allows the company to identify and rate potential job candidates.

During the summer of 2000, the NCSU Computer Science department and the IBM STG initiated a dialogue concerning opportunities to provide practical industry experience for students while contributing code to the IBM VisualAge for Smalltalk (VAST) product. The IBM STG had two motivating factors in these discussions. The first factor was that a growing number of small, well-defined, program enhancements for the VAST product needed to be made. Experience had shown that interns or students would be capable of performing the tasks with proper supervision. The second factor was the need to evangelize Smalltalk (in general, not just VAST). Smalltalk had gotten lost in the Java flood of the last several years. However, yet again, to paraphrase Mark Twain, "The rumors of Smalltalk's demise [had] been greatly exaggerated." Smalltalk remains a superior, viable

object-oriented environment with many strengths that other languages cannot match.

In the fall of 2000, the IBM STG was relocated to an industrial park less than two miles from the main NCSU campus. A university bus stop about 100 feet from the front entrance gave students easy access to IBM STG facilities. Meanwhile, the lead author's master's level Object-Oriented Languages and Systems course attracted nearly 90 on-campus students, which was the largest number of on-campus students it had ever had. Such a large class size makes it very difficult for the faculty to give individual direction to students. It also increases the pool of potential applicants for cooperative projects.

Several weeks before the start of the spring semester, the IBM STG identified three potential projects and e-mailed descriptions to the lead author for consideration. He relayed them to the students in his class, asking them to reply if interested. The students were told that this work would be structured as a 3-credit independent-study project for academic credit rather than pay. Fifteen of the students indicated interest. The projects were then offered to the top seven applicants (rated by performance in the lead author's course). Six students accepted the project assignments. Although this number of students was higher than the original 3-to-5-person staffing level sought by IBM STG, all six students were assigned to projects. Three projects were staffed with two students each.

2. Organizing the Team

The student project teams were comprised of two students each with a full-time IBM STG team member acting as a mentor. The mentors were responsible for project guidelines, requirements, and direction. Project leadership and execution were student responsibilities. The goal was to have the students work in an environment similar to an industry scenario. The three student projects were as follows:

1. VAST Web Services Interface
2. VAST HTTP 1.1 Enhancements
3. VAST Performance Benchmarks

The axiom, "Plan your work and then work your plan," is a key to a successful project. To successfully execute these student projects, tasks would need to be:

1. Kept small,
2. Well defined, and
3. Properly supervised

The IBM STG reworked several VAST product plans in order to accommodate student schedules. At least one VAST project was broken down into multiple smaller segments. The goal was to insure that there was a functioning deliverable at the end of each project segment. This is a common industry practice used as a safeguard against uncertainty. It allows "success" to be declared as long as at least one segment of the project was completed. The end result of this exercise was a manageable schedule with more clearly defined goals for the student projects. The IBM STG scheduled reviews of student projects to insure projects were moving forward. These reviews were structured to be similar to those of standard development review processes.

3. The Industry Experience

Incorporating new members into a team is an essential task. For a team to succeed, all team members need to succeed. In this case, whether they are full-time employees, supplemental employees, or interns does not make a difference. All team members must be enabled and equipped for success. To this end, within 48 hours of the six students coming to the IBM STG, physical accommodations were setup in a large spare office and a new VAST library manager was brought on line. Four additional workstations were also brought on line within the next two weeks to provide students with the physical resources they would need to successfully com-

plete their projects. This included everything from physically setting up the machines to installing and configuring special software to support project requirements. Students were granted access to the IBM STG facilities from 8:00 AM to 6:00 PM, Monday to Friday.

Due to the limited time frame (one university semester) for this activity, getting through this initial “setup” phase as quickly as possible was felt to be crucial. To insure sufficient time for the success of the student projects, the entire IBM STG team (including the NCSU students) contributed to getting this done. It may take six months to a year to successfully bring a new hire onto a product team. Due to the limited scope of these student projects, this process was accomplished in a couple of weeks.

During the initial weeks of the project, students and mentors prepared for the upcoming projects using available lab resources. Mentors were able to fine-tune project plans and insure user IDs were set up where they needed to be. The students received a crash course in the VAST product. All the students were generally versed in the Smalltalk language and the OO concepts that Smalltalk embodies. However, none of the students were familiar with the VAST Smalltalk environment that they would be working with for the projects. Therefore, the IBM STG team gave a combination of tutorial sessions, one-on-one sessions, and hands-on On-the-Job-Training (OJT). The students also utilized References 1, 2, and 3. Further time was spent reviewing programming specifications related to the upcoming projects—specifically, the HTTP 1.1 and Web Services specifications.

After this training and planning period, the teams were ready to get to work on their projects. From the time the NCSU students were introduced to the IBM STG team, it was only about three weeks before things really started to happen. One by one, the plans made in the previous weeks started to fall into place. Performance

benchmark platforms came together and results started to flow in. The HTTP 1.1 team got a prototype HTTP server running and the Web Services interface started to take shape.

Like most projects, “things happened” (though not by intent or design) as the projects progressed. Code changes are fairly well understood and documented in technical literature (see references 4 and 5 as examples). However, changes due to non-code related issues (e.g., plans, priorities, and resources) are less well understood. Perhaps the best documentation for these issues are non-technical texts (e.g., references 6, 7, and 8). The students received exposure and learned to deal with both types of changes over the course of their projects.

4. Student Experience

Students were interested in undertaking this project for a variety of reasons. The most frequently cited reason was their desire to work on a project that produced real commercial software. The students anticipated that this would be quite different from working on class projects, and thought it would enhance their opportunities for employment, as well as giving them a frame of reference when evaluating prospective work environments. The second most common reason, cited by two of the six students, was an opportunity to program in Smalltalk. As one of them put it, “I was instantly hooked on Smalltalk. ... This project represented an opportunity [to use it professionally].”

The team environment was cited by almost all of the students as a major advantage of the project. They enjoyed the experience of cooperating toward a common goal. They found they learned more than in classes, because they had an opportunity to learn from several IBM team members, as well as from each other.

A semester-long project is short enough that students might still have the opportunity to work on another industrial project, say, in a summer job

or internship, during the course of their graduate study. All of the students expressed interest in doing this, except for one who was graduating at the end of the semester. This would give them a breadth of experience that few master's graduates possess.

The project was circumscribed well enough that it didn't get in the way of the students' classes. One of them reported working on it four to eight hours a week. Another one had classes every afternoon, but the close proximity of the lab to campus allowed her to work there in the mornings.

During a master's degree program, each student is allowed to do one or two independent-study projects (thesis students are allowed only one; non-thesis, two). These can be a valuable experience, in that outside of a thesis, they are a student's best opportunity to work closely with a faculty member. However, good direction is essential for the student to get maximum value from the experience.

The IBM STG did what we faculty never could have done on our own in furnishing a lab and providing individualized on-site instruction and consulting to help them learn a state-of-the-art commercial programming environment. The large number of students we are faced with today simply makes it impossible to give each student the attention we would like to. No university could afford a ratio of about two instructors or TAs to one student.

5. In the End ...

Ultimately, all the student projects were successful and that is really what counted the most. The students had a positive experience and were able exercise and reinforce what they had learned in their classes. Every one of them declared that their experience was worthwhile, and that they would recommend such a project to others. The IBM STG team benefited from this exercise in a

couple of different ways. First, from a VAST product perspective, the IBM STG received:

1. A set of VAST benchmarks
2. Code for a Web Services Interface
3. Code for HTTP Server Enhancements

These enhancements can only improve the VAST product. Second, from a people perspective, the IBM STG was able to:

1. Introduce six new people into the community of Smalltalk programmers.
2. Retain a permanent hire.
3. Obtain a summer intern.

The IBM STG did not enter this activity specifically looking to fill any open job positions. However, it is not surprising that this occurred. Placing talented individuals in the proximity of opportunity is the first step in making things happen.

There is over 100 years of software experience within the IBM STG team. The team itself is a diverse collection of individuals. There is also no doubt that the IBM STG team learned some new things from the NCSU students. It is hoped that the NCSU students were able to take something from this pool of experience that will make them more efficient professionals and aid in their future success.

This cooperative arrangement is continuing during summer 2001, with two other students working on projects with the IBM STG. We intend for this to be a continuing relationship. However, the 100% success rate of the initial student projects may be tough to duplicate. There is no guarantee of success for any industry project.

6. Intellectual-Property Issues

Projects like these also raise significant intellectual-property concerns. The IBM and NCSU legal departments were working on them while

the projects were in progress. IBM initially proposed that any code or documentation generated by the project would be owned by IBM. In the final agreement, this was changed to specify that the parties would jointly own the materials that were developed. IBM was granted the right to license these materials to others without the consent of the students or NCSU. Other negotiating points concerned which state's laws (New York's or North Carolina's) would govern the agreement, and how long the university would guarantee that the students would not divulge any secrets they learned in the course of their participation.

7. Perspective

An academic program should be a blend of theory and practice. Universities are well equipped to provide the theoretical. Furnishing enriching practical experiences, however, requires a large commitment of faculty time, and even then, faculty are not necessarily attuned to the most current industrial practice. Therefore, it is valuable to get industry involved in this aspect of education. The model that we have outlined here—close industrial supervision of limited-time projects by students—is one that has proved valuable to our students and their industrial mentors. We intend to pursue more projects of this nature, and we encourage others to explore them too.

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