CEINT INTERNSHIP PROGRAM

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Abstract – Arizona State University, Motorola, and Intel have formed CEINT, the Consortium for Embedded and Inter-Networking Technologies. CEINT sponsors paid internships for students in Computer Science and Engineering. A student earns three credit hours per term for an internship, and a student can continue an internship for as long as three terms. An intern works 20 hours per week during the spring or fall semester, and 40 hours per week during the summer term. The internships are not just part-time jobs—each student participates as a member of a professional design and development team. Each student has an industrial mentor and a faculty mentor. At the end of the term, every student submits a final written report and makes a final oral presentation. In the spring semester of 2003, we had formal presentations from 23 interns. We organized the presentations as a one-day conference, and more than one hundred people attended the talks.

Index Terms – Capstone and design experiences, formal student presentations, paid industrial internships, university-industrial consortium.

FORMATION OF CEINT

In 2000 and 2001, representatives from Arizona State University (ASU), Motorola, and Intel worked together to form CEINT, the Consortium for Embedded and Inter-Networking Technologies.

Motorola and Intel had previously recognized the fact that they faced a difficult mutual challenge in trying to recruit new college graduates who could work productively on the design and development of embedded microprocessor and microcontroller systems without the need for extensive post-college training. The companies felt that they could improve the situation by forming an active partnership with ASU to enhance education, both at ASU and at other universities, in the area of embedded systems. [1]

After several months of groundwork and preparation, CEINT finally became a reality in the spring of 2001. With funding in place from all three founding members, CEINT established an aggressive, three-pronged program. The consortium

(1) Sponsored paid student internships carrying academic credit,
(2) Provided university grants for curriculum development in the area of embedded systems,
(3) Funded university research projects relating to embedded systems, and
(4) Provided scholarships for students with interests in embedded systems.

In this paper we focus on the student internships, which are for ASU students in Computer Science and Engineering.

ACADEMIC CREDIT FOR INTERNSHIPS

The corporate members of the consortium felt strongly that the internships should not be just paid internships but should also include academic credit. The academic credit would distinguish the internships from mere part-time jobs and would make them more prestigious and more appealing to students.

To qualify for academic credit, of course, the internships had to meet rigorous educational objectives that would merit the approval of the faculty of the department of Computer Science and Engineering (CSE). ASU faculty representatives worked to establish detailed internship guidelines and procedures that would ensure the educational value of the internships, and the CSE faculty approved the internship program as CSE-484, a senior-level technical elective, in the late spring of 2001.

A student earns three credit hours per term for an internship, and a student can count as many as six credit hours of internship credit toward graduation requirements as technical electives. The academic program does not require internship credit for all students, of course, because the stringent internship eligibility requirements limit the number of students who qualify for the program. The internships therefore appear as technical electives on the student’s program of study.

Although a student can count a maximum of six credit hours (two terms) of internship credit toward graduation requirements, a student is eligible to remain in an internship for three terms. This policy allows a student to be in an internship for a full year, typically including one summer of full-time internship work.

ELIGIBILITY AND PREREQUISITES

To be eligible to apply for an internship, a student must have a cumulative GPA of 3.0 or higher, so the program is available only for strong students. The CEINT corporate partners naturally want to recruit the best students, and the highly desirable internships serve as a substantial incentive to encourage students to do well in their academic programs.
In addition to meeting the GPA requirement, a student must complete two prerequisite courses to be eligible for an internship. The prerequisites are CSE-421, Microprocessor System Design I and CSE-360, Introduction to Software Engineering. We wanted the interns to participate as contributing members of professional design and development teams working on state-of-the-art new industrial products, and we quickly found that these two courses were essential requirements that gave the students the background they had to have for the internship projects.

The fact that the prerequisite courses are at the junior and senior level means that the students have also completed their other courses through at least the junior level and have attained a reasonable level of broad technical expertise and maturity. The internship therefore comes at the end of a student’s undergraduate career and serves as a real-world capstone experience. In fact, the internship program is better than a typical capstone course in a purely academic setting because the internship serves as a natural stepping-stone from college to the student’s future career in industry.

**INDUSTRIAL MENTORS**

A potential industrial mentor at a sponsoring corporate partner takes the first step toward creating an internship project by submitting a proposal for the internship. The proposal explains what the student will do and what the student will learn during the term of the internship.

Each internship includes three components: (1) training (not necessarily formal; perhaps on-the-job training), (2) mentoring (daily guidance and review from the student’s industrial mentor), and (3) a project (typically with a professional development team; actual development and not just a routine job such as running backups or working at a help desk). The project must also help the student develop team skills and communication skills.

Company representatives and the ASU Internship Director (a faculty member who supervises the internship program) review each internship proposal to ensure that the proposed internship is suitable and meets desired educational goals.

The industrial mentor is often a working member of a development team, so the mentor usually works directly with the intern on a daily basis. The leader of a development team can also be an industrial mentor, in which case a working member of the team may work directly with the intern and assume part of the mentoring role.

**APPLICATION AND SELECTION PROCESS**

The internship program is available for international students as well as being available for American students. Some particular projects may be unavailable for international students because of export restrictions or citizenship requirements, but most internship projects are available for international students as well as other students.

A student who has completed or is taking the prerequisite courses and meets the 3.0 GPA requirement applies for an internship by submitting a resume and a current copy of the student’s ASU transcript to the Internship Director. The project sponsors (i.e., work groups in the companies that are corporate consortium partners) select students for in-plant interviews, interview the students, and choose students for their projects. Each project sponsor develops a rank-ordered list of selected students. The students also have the opportunity to provide rank-ordered choices of projects to the Internship Director. Following the interviews, the Internship Director meets with company representatives to decide how to allocate selected students among the various projects.

**WORK REQUIREMENTS AND GRADING**

A student who earns internship credit during a spring or fall semester must work 20 hours per week throughout the semester, and a student who earns internship credit during the summer must work 40 hours per week throughout the eight-week ASU summer session.

A student may understandably have difficulty working 20 hours every week during a fall or spring semester because of the inevitable extra demands of midterm exams, semester projects, and final exams. A student who encounters this problem can, with approval from the student’s industrial mentor, take some time off during a busy week. In this case, the student must work extra hours (up to 40 hours per week) during spring break or during the winter break to compensate for missing work time during exams.

A student who works on an internship during the summer normally works for the entire summer instead of working just for the eight weeks of the ASU summer session. The requirement for academic credit includes only the eight weeks of the ASU summer session, but most interns actually work for the entire twelve weeks of the summer break to earn more money and to gain more experience.

We award Y/E (i.e., credit/failure) grades for internships, so the grade for an internship doesn’t unfairly raise or lower a student’s GPA. A student with an internship neither gains nor loses in terms of GPA relative to students who don’t have internships. Another reason for avoiding letter grades is that every internship is unique, so the basis for comparison from one student to another is tenuous.

**INTERN PAYMENT AND MONITORING**

We currently pay the interns through ASU to make the pay rates uniform. The rates of pay are $14/hour for the first term, $16/hour for the second term, and $18/hour for the third term. The corporate partners reimburse the university for these expenses plus the overhead that is necessary to administer the program.

Each intern must submit a time log to the Internship Director, to the student’s faculty internship mentor, and to
the student’s industrial internship mentor at the end of every week. The time log must show the hours worked each day and must include a narrative to explain the activity for each day of the reporting period. The time log must also include a weekly summary that briefly summarizes the activities, progress, difficulties, and learning outcomes for the entire week.

Note that each intern has both an industrial mentor and a faculty mentor. The industrial mentor nurtures the student and supervises the student’s work on a daily basis, and the faculty mentor monitors the student’s progress and ensures the academic integrity of the internship experience.

Both the industrial mentor and the faculty mentor review the student’s time log each week and give the student weekly feedback to keep the student on the right track throughout the term of the internship. The Internship Director also reviews each student’s time log each week to provide an additional check.

**Faculty Mentors**

A faculty member (perhaps the Internship Director, who is a faculty member) serves as a faculty mentor for each intern. The faculty mentor monitors the internship project and the student intern throughout the term of the project to ensure that the project and the student continue to meet desired educational objectives. The faculty mentor also reviews the student’s time log each week and gives the student feedback to keep the student on the right track.

While the industrial mentors work with the interns on a daily basis and therefore provide most of the mentoring, the faculty mentors are also an important part of the internship program. The faculty mentors provide an academic viewpoint and maintain the academic integrity of the program.

Being a faculty mentor requires some time and effort, so a faculty member must have a motivation for being a faculty mentor. The consortium recognizes the importance of the faculty mentors, so the consortium pays each faculty mentor a stipend every semester for each student intern that a faculty member supervises. The stipend isn’t enough to attract a faculty member who doesn’t care about being a faculty mentor, but the stipend does compensate for the time and effort that the faculty member devotes to the program.

**End-of-Term Procedures**

At the end of each term, every intern makes an on-campus oral presentation to explain the internship project and the student’s achievements. The corporate sponsor may also require the student to make a presentation at the company’s site so that members of the project team can conveniently attend. The company presentation normally occurs a few days before the public presentation so the student can gain experience in front of a smaller group and so the company can verify that the presentation will not reveal any proprietary information.

Each intern also submits a final written report explaining what the student learned from the internship, what the student accomplished, what the project team accomplished, and what the student might suggest for improving the internship experience in the future. The industrial mentor, the faculty mentor, and the Internship Director all review this report.

The oral presentations at the end of the term are a major event for everyone in the internship program. We organize the presentations as a one-day technical conference, very much like any technical conference. Each student gives a 15-minute formal presentation, and the presentations are surprisingly technical, professional, and polished. Many attendees remark that the student presentations are every bit as good as any presentations that they have seen at any technical conference.

One of the goals of the internship program was to help develop the presentation skills of our students, and this aspect of the program has evidently been wildly successful.

Last semester (spring, 2003) we had presentations from 23 interns, and more than one hundred people from industry and academia attended our all-day conference.

**Program Growth**

We intentionally started this internship program as a small program so we could refine it and experiment with the details before the program became large. We started with just seven interns in the summer of 2001, and we provided initial orientation and training sessions for the interns, for the industrial mentors, and for the faculty mentors. We solicited feedback from everyone involved in the program and from others who were external interested parties, and we used that feedback along with our first-term experience to refine some of the details of the program. For example, we settled on weekly time-log reports from the students after trying reports every two weeks and finding that we needed to monitor the projects and the students in a more timely fashion.

We continued with only the original seven students in the fall semester of 2001 to stabilize the program and to test it in the environment of an academic semester. The results were extremely — one might even say surprisingly — good. All of the seven original students stayed in the program and completed their required work hours and assignments. We had feared that their grades in their other classes might drop as a result of the time and attention demands of the internships, but their grades actually improved while they were in the internship program!

We started to grow the program in the spring of 2002. We have grown steadily each semester, and we now have 28 students in the program during the summer of 2003 with prospects for more growth in the future. We are continuing to grow the program, but continued growth will bring some new challenges. For example, as the program gets larger and larger, it will eventually outgrow the ability of the
Internship Director to manage it on a part-time basis. The position of the Internship Director may eventually become a primary or perhaps half-time assignment for some faculty member.

Our corporate partners will eventually reach their capacities for the number of interns they can accommodate effectively, and we will eventually encounter a shortage of well-qualified students. We can solve the problem of the capacities of the corporate partners by welcoming more corporate partners into the consortium, and we can address the potential shortage of well-qualified students by using the internships to attract more and better students into our undergraduate program. We could also open the program to graduate students, in which case we would greatly expand our pool of qualified students.

**NOTABLE SUCCESSES**

The students in the internship program have been remarkably successful. Most of them have improved their already-excellent grades while participating in the program, and the vast majority of them continue in the program until graduating or exhausting their eligibility. The corporate sponsors and industrial mentors have been surprised at the contributions and quality of the students, and the students themselves have had nothing but praise for the program. For example, consider the following statements from interns.

“CEINT has given me the opportunity to gain hardware design skills that I never would have learned in a classroom. My internship through the Motorola Computer Group allowed me to work on a product from the design stage to the production stage. This experience has left me standing tall, confident, and well prepared for the job market. A student cannot ask for much more!” — Joey Castro.

“The internship program has given me an opportunity to expand my current skill set and practice using the tools I have learned at ASU. … The best thing the program offers is a chance to work in an environment that would normally not be available to undergrads. … The knowledge I have gained during the past year at Intel has ensured that I will be a valuable commodity in the Embedded Systems market.”

— Kyle Gilsdorf

“I have gained valuable experience in Software Engineering through the internship program. I have had fun and learned more about what interests me in the computer-engineering field. The internship has also helped me in obtaining interest from potential employers for post-graduation employment. It has been an invaluable experience.” — Justin Schaub

These statements are typical of the feedback we have received from students. Many of them have said that the internship “is the best thing that has ever happened to me at ASU.”

Another indication of the success of the program is the fact that the corporate sponsors themselves have hired nearly all of the interns into full-time positions when the students have graduated. The few interns who have gone to other companies upon graduation have cited the internship program as something that made them very attractive to the companies that hired them.

Remarkably, two of our interns have their names listed on patent applications as a result of their internship work. This situation attests to the fact that the students are contributing members of professional teams doing state-of-the-art design and development work.

**INDUSTRIAL SUPPORT**

Unfortunately, not every university can duplicate this internship program. ASU is in a large metropolitan area with a considerable amount of high-tech employment, and this setting or a similar setting is necessary for this program to work well. A university or college in a college town that has relatively little high-tech employment would not be able to find local sponsors for suitable part-time internships during the academic semesters. Such a university could work with corporate sponsors at remote locations to establish a summer internship program, but a program with remote sponsors would necessarily exclude many of the key aspects of our program. For example, the one-day conference presentations at the end of each term would be difficult when the potential corporate attendees are at a considerable distance from the university.

Even a university with access to plenty of local high-tech companies faces a significant challenge. We were fortunate that Motorola and Intel both had the foresight and wisdom to contribute to this program as we have designed it. Not every company is willing to spend the extra time and money to make an internship program educationally sound. We have, in fact, encountered other companies that want a similar but cheaper internship program that eliminates most of the educational aspects of the program and turns it into a commonplace program of part-time jobs for students. A strong commitment from corporate partners with wisdom and foresight is a necessary ingredient for the success of this internship program.

**WIN/WIN/WIN**

The internship program that we have created provides a true win/win/win situation. The corporate partners win, and university wins, and, most importantly, the students win.

**Corporate Partners Win**

The corporate partners make a large investment of time, money, and resources, but they get a significant return on their investments. They get the opportunity to recruit the best students in our program before those students graduate and become visible to the rest of the potential employers in the marketplace. They get to train those students, educating them to use the latest tools and imbuing them with the company’s corporate culture and procedures. As a result the interns are already valuable contributors and can be
The University Wins

With our program, the consortium not only sponsors internships but also funds grants for curriculum development and research projects. The curriculum development provides immediate benefits for the university, and the research projects are also important sources of funding and interesting work for faculty members and students.

The university would still gain from the internship program even without the grants, however. First, the internship program is appealing to the students, and it helps attract better students into the program. Second, the students actually do better in their normal classes as a result of the internship program, and many of them remark that the internship changes the student's financial circumstances substantially.

The corporate sponsors have an inherent advantage in terms of being able to recruit their own interns. The interns are already familiar with the company, with the work environment, and with their co-workers. The interns feel comfortable with the company and loyal to it, and they uniformly express the fact that they like the company and want to work for the company when they graduate.

While the company has a clear recruiting advantage, the company does not have any long-term commitment. Hiring a person as a full-time employee involves a commitment, but a company can decide that an intern, while good, is not good enough to recruit for a full-time position. In that case, the company can simply wish the intern well at the end of the internship, and the student enters the job market with no stain and with the palpable advantage of the experience of the internship.

Finally, the industrial mentors report that the interns are surprisingly valuable in terms of the contributions that they make while they are interns. Rather than being a drain on a group’s resources, an intern typically learns quickly and soon provides a tangible benefit for the work group.

In short, the corporate sponsor gains a tremendous recruiting advantage for the best students without making any long-term commitments, and the students make positive contributions even while they are interns.

The Students Win

Most importantly, the students win, and the students probably win most of all.

Perhaps the most obvious benefit is the practical experience that the students gain. They move out of the classroom and into the world of industry on a part-time basis in a sheltered, educational environment with an industrial mentor to help them on a daily basis and with a faculty mentor also standing behind them. The students universally report that they enjoy the internships and that they learn many things that they would never learn in the classroom. They also say that the internship experience gives them a better appreciation and understanding of the things that they do learn in their normal classes.

Another significant benefit that we haven’t emphasized previously is the fact that a student earns a significant income from the internship. Students are typically on tight budgets, and the income that a student gets from an internship changes the student’s financial circumstances substantially.

Finally, just as the internships give the corporate sponsors a recruiting edge, they similarly give the students a tremendous job-seeking advantage. An intern already has a foot in the door at the sponsoring company, and the intern is already a valuable member of a professional development team. The student’s co-workers are typically advocates for hiring the student. The intern clearly has a significant advantage over other new graduates when seeking a job with the sponsoring company.

Also, the intern already knows the company and the people in the company, so the intern feels comfortable and confident about taking a full-time job with the company. Contrast this happy circumstance with the uncertainty that a typical new graduate faces when taking a job in a new city with an unknown work situation on the basis of a one-day interview.

Even if an intern doesn’t take a job with the sponsoring company, the intern still has a significant job-seeking advantage over other new graduates. Other companies value the intern’s practical experience and demonstrated work ethic, and the corporate world is not a big mystery to a student who has been working in it for a year.

CONCLUSION

The CEINT internship program at ASU has been in place since the summer of 2001. It started with only seven students and has grown steadily to the current level of 28 student interns. The consortium is open to new corporate partners, and the prospects for the future are bright.

The program has been successful by every measure. The corporate partners are happy as evidenced by their increases in the number of internships, and they have had great success at recruiting highly desirable interns to full-
time jobs upon graduation. The university has obtained significant CEINT grant funding and has scored points with the students because of the internship program. Finally, the students have universally reported that they greatly appreciate the internship program, and many of them have gone to work for the corporate sponsors of the program upon graduation. Without question, the CEINT internship program provides a true *win/win/win* situation.

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**REFERENCES**