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# My Student, My Teacher: A Polytechnic Approach to Information Assurance

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# A Polytechnic Approach to Information Assurance

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## ABSTRACT

A polytechnic education involves the practical application of knowledge, including hands-on learning, senior projects, class projects, club activities, professional association activities, and internships. In 1824, the first polytechnic institution in the United States was the Rensselaer School in Troy, New York and today there are approximately 100 polytechnic universities. Several polytechnic institutions are leaders in teaching information assurance. Information assurance educators develop and depend on students to provide leadership in information assurance through active, engaged learning. The goal of this paper is to describe how a polytechnic approach supports information assurance education.

## INTRODUCTION

In 1799, The Royal Institution of Great Britain was founded with the goal of "the promotion, diffusion and extension of science and useful knowledge" (McMaster, 1991). Over the last two hundred and eight years, polytechnic universities have been viewed as more practical than a pure liberal arts education. In a December 2006 report, declaring their intention to become Wisconsin's polytechnic university, the President of the University of Wisconsin-Stout defined a 21st century polytechnic university as follows:

"Polytechnics are comprehensive universities offering professional, career-focused programs in the arts, social and related behavioral sciences, engineering, education, and natural sciences and technology that engage students in active, applied learning, theory and research essential to the future of society, business and industry." (Sorenson, 2006).

In 1925, the first of two polytechnic universities in the California State University system, Cal Poly San Luis Obispo, began requiring all students to complete "enterprise projects" that had both "educational and commercial merit" (Loe and Howard-Greene, 2001). At Cal Poly and other institutions, senior level culminating experiences have been found to give students an opportunity to synthesize material learned in a range of courses and to apply what they have learned to a practical, "real world" problem (Davis et al., 2004). At Cal Poly Pomona, industry supported senior projects in a teamwork environment "drastically improves the students' leadership ability both inside and outside of the classroom and their opportunity for successful careers" (Glozman, 2000).

As of 2007, several polytechnic institutions, including Polytechnic University of New York, Virginia Polytechnic Institute and State University, and California State Polytechnic University, Pomona (Cal Poly Pomona) were among a select group of institutions designated by the National Security Administration and Department of Homeland Security as Centers of Academic Excellence in Information Assurance Education (CAE/IAE). This paper will focus on activities of a polytechnic institution that have enabled Cal Poly Pomona to be designated a CAE/IAE. These activities include senior projects, class projects, club activities, professional association activities, and internships. These activities are not unique to polytechnic institutions. All universities can benefit from taking this active, engaged learning approach to higher education.

### Cal Poly Pomona Senior Project Class

At Cal Poly Pomona, the Computer Information Systems Department has a capstone class that draws upon the student's knowledge obtained in their coursework and combines it with relevant service to the community.

Students taking the senior project course work on CIS related projects for actual clients, providing a real world example of a small CIS consulting group. Clients from industry or the campus community present to teams of students a business problem that needs to be solved. Students form their teams with those students they have worked with in previous classes or form new relationships. Each student on the team is assigned a role such as project manager, web master/documentation/training analyst, systems analyst, programming guru, or team leader. Each project may require additional roles such as network analyst depending on the business problem.

The projects involve the students working in a team environment, preparing proposals, budgets, meeting with client(s), developing requirements, designing prototype system, testing, evaluation and implementation. Once teams have been assigned to a client, a series of five presentations will be held with the client. The first two meetings are called Joint Application Development (JAD) sessions where the team understands the current system while gathering requirements for the new system as well as any constraints (McConnell, 1996). Once the requirements have been gathered, three prototype sessions are held where the graphical user interface, database design, or network design is presented to the client. Throughout this process students are gathering detailed feedback on their solution to their business problem.

The final result is a documented solution to a problem or project posed by a client. Solutions are presented to the client during finals week. The solution may involve designing and installing a new telecommunications network; designing and coding a desktop or web-based application; or creating websites for elementary schools. Clients provide faculty with intermediate and end of project evaluation as to the team's performance and whether they met the needs of the client. Client performance feedback has been ongoing since 1995.

Information assurance senior projects have increased in the last few years. One reason is increased customer awareness of the need to address information security and privacy issues. Another reason is the reputation of Cal Poly Pomona as a CAE/IAE. A third reason is increased interest by students in gaining real-world experience in information assurance. These projects have included a campus network assessment, divisional data inventory, computer forensics training video, computer forensics software evaluation, security simulation game scenario, and creation of a honeynet. Projects are summarized in Table 1.

**Table 1: Information Assurance Senior Projects at Cal Poly Pomona.**

| Project Date | Project Customer | Project Deliverables |
|---|---|---|
| Spring 2005 | Cal Poly Pomona Instructional and Information Technology Division | Provided Cal Poly Pomona with a thorough Network Security Assessment by identifying current strengths and weaknesses. Provided suggestions (products, practices and procedures) to increase existing Network Security. |
| Spring 2006 | Cal Poly Pomona Student Affairs Information Technology Group | An executive summary for the Division of Student Affairs Cabinet that included:<br>1. Server inventory<br>2. Asset inventory<br>3. Complete list of all network attached devices<br>4. Risk assessment as to the state of software patching and backup in each department |
| Summer 2006 | Southern California Honeynet Research Project | Re-establishment of a honeynet for the Southern California Honeynet Research Project, included:<br>1. Network design (completed with the assistance of the client)<br>2. Installed a secured configuration of PC operating systems and applications, including a public web server<br>3. Configured network hardware |
| Summer 2006 | Naval Postgraduate School in Monterey | Created an academic version of the CyberCIEGE security simulation game developed at the Naval Postgraduate School in Monterey. |

| | | |
|---|---|---|
| Summer 2006 | Cal Poly Pomona Computer Information Systems Department Faculty | Created a training video on the forensically sound methods that should be followed when seizing digital evidence. Detailed accepted best practices when seizing all forms of digital evidence such as a desktop hard drive, laptop hard drive, cell phones, and a PDA. The video also demonstrated the process of labeling evidence and preparing evidence for transportation. (www.digital-assurance.net) |
| Summer 2006 | Cal Poly Pomona Computer Information Systems Department Faculty | Compared open source forensic tools to commercial forensics tools. Linux open source tools were evaluated for ease of use, functionality, and reliability. Results were presented at the Hawaii International Conference on System Sciences (Manson, et al. 2007). |

## Professional association activities

The synergy between academic programs and related information assurance professional associations is significant. One example is the Information Systems Audit and Control Association (ISACA). ISACA is an international organization with over 50,000 members, over 170 chapters in over 70 countries. On their website, ISACA states their relationship with higher education as follows:

"Universities are encouraged to disseminate information about ISACA, network with faculty and students interested in learning more about the IS audit profession, encourage compliance with the ISACA standards and Code of Professional Ethics, and provide a forum for ideas and suggestions from within the academic community" (Information Systems Audit and Control Association, 2007).

In September 2005, Cal Poly Pomona became one of three universities in Southern California to have a student ISACA chapter. Over the past 25 years, Cal Poly Pomona has maintained a close relationship with the Los Angeles Chapter of ISACA, including scholarships, best paper awards, and student attendance at ISACA meetings and conferences. The Information Systems Audit and Control Association's Los Angeles Chapter sponsors a Best Paper Contest as a part of their academic relations initiative for full time undergraduate and graduate students. The contest encourages college students to promote knowledge in Information Systems Auditing. The winner's paper will be published in the Information Systems Control Journal®. Last year, two Cal Poly students won the award.

In July 2003, the Inland Empire Chapter of the Information Systems Security Association (ISSA) was formed. "The primary goal of ISSA is to promote management practices that will ensure availability, integrity and confidentiality of organizational resources" (Information Systems Security Association, 2007). The initial chapter board included Cal Poly Pomona CIS students as board members. In February 2004, two students from the College of Business Administration were each awarded $2,500 scholarships from the Los Angeles Chapter.

In spring 2006 Cal Poly Pomona hosted the annual training day of the Southern California Chapter of the High Tech Crime Investigation Association (HTCIA). Cal Poly Pomona has also hosted monthly meetings of HTCIA, with student attendance at both the training day and monthly meetings. Table 2 summarizes Cal Poly Pomona Information Assurance involvement with professional associations.

**Table 2: Information Assurance activities with Professional Associations at Cal Poly Pomona.**

| Professional Association | Types of Student Involvement |
|---|---|
| ISSA | Membership, Meetings, Conferences, Board Members, Scholarships, Best Paper Contests |
| ISACA | Membership, Meetings, Conferences, Scholarship, Best Paper Contests, Journal Publications, Student Chapter |
| HTCIA | Membership, Meetings, Training |

## Student Club Activities

The Students with an Interest in the Future of Telecommunications (SWIFT) student club hosts many events on topics of interest to students. One such session was to prepare students to participate in Microsoft's Imagine Cup Competition. The 2007 competition wanted students to apply technology and artistic talent to improve education. A series of elimination rounds are conducted where students advance and once they reach national finals, they are placed into a team. The team would represent the United States in the international competition. SWIFT identified one category where students could showcase their software design and programming skills. SWIFT scheduled two four hour sessions on Friday and Saturday afternoons so as to not interfere with class schedules. Our Microsoft Evangelist led the session to encourage students to sign up and compete for the competition. All attendees received an academic version of the new Microsoft Vista operating system. As a result, 57 students competed in the competition and resulted in Cal Poly being the lead school in the competition.

In October 2005, students from SWIFT presented at the Cal Poly Pomona Cyber Wellness Fair on "Phishing, AntiVirus, Spyware Removal & Importance of Updates and Service Packs". The presentation was well-received, and led to the students making a similar presentation at the 2006 California ID Theft Summit at the Los Angeles Convention Center. Offered twice during the summit, this presentation provided more than 200 attendees with techniques to stay safe online and avoid becoming victims of fraud, identity theft, or cyber crime.

SWIFT also supports a Wireless Telecommunications Symposium held every April where information is shared on advances in the mobile and wireless networking field. Leaders and experts from industry, governmental agencies, and universities around the world attend (http://www.csupomona.edu/~wtsi). CIS students are not only a resource for conference logistics but also act as ambassadors to the numerous staff, students, and industry personnel that attend the event.

For the last two years, the Cal Poly Pomona MISSA (Management Information Systems Student Association) student club has included a computer forensics competition in their annual Information Technology Competition. In 2006, five teams from two schools competed in a live forensics case investigation. The case was developed by a Cal Poly Alumni working for the Orange County District Attorneys office, and was judged by industry professionals. In 2007, five teams from three schools competed in a live forensics case investigation. The case was developed and judged by Guidance Software, a leading vendor of computer forensics software.

## Class Projects

Undergraduate and graduate courses in computer security, forensics and audit provide students with many opportunities for hands-on real-world information assurance projects. These projects may have internal campus or external customers. Examples include software evaluation, campus security awareness and security risk assessment assistance, and audits. Table 3 highlights information assurance related class projects over the past several years.

**Table 3: Information Assurance Class Projects at Cal Poly Pomona.**

| Class Project Date | Project Description | Deliverables |
|---|---|---|
| Summer 2003 | Evaluate campus compliance with new security breach legislation. | Compliance report |
| Fall 2004 | Create Security Awareness Videos for the EDUCAUSE Contest. | Video submission to the contest. |
| Winter 2006 | Create Security Awareness Videos for the EDUCAUSE Contest. | Video submission to the contest. |

The summer 2003 compliance audit project provided an example of students taking a leadership role in information assurance. In response to major security breaches involving confidential information, the State of California passed a law effective July 1, 2003 that requires "a state agency, or a person or business that conducts business in California, that owns or licenses computerized data that includes personal information, as defined, to disclose in specified ways, any breach of the security of the data, as defined, to any resident of California whose unencrypted personal information was, or is reasonably believed to have been, acquired by an unauthorized person" (California

State Senate, 2003). The Cal Poly Pomona Computer Information Systems Internet Security class was assigned a project to determine whether Cal Poly Pomona was complying with the new legislation. Within two weeks of starting the project, students found class rosters containing confidential data that was on a publicly accessible website. Within four weeks of starting the project, students whose confidential data were on the class rosters received notification letters in accordance with the new legislation. Some students who worked on the project actually received notification letters. This class project enabled Poly Pomona to be among the first institutions in California to evaluate and take action based on the new security breach notification legislation.

Another example of a class project is the EDUCAUSE Security Task Force Video Contest. EDUCAUSE is a nonprofit organization whose charter is to advance higher education by promoting the intelligent use of information technology (EDUCAUSE, 2007). In 2006, EDUCAUSE held their first annual security video contest for college students. College students were asked to create videos for the college student audience on a short security topic that would safeguard their computers and personal information. The contest included 62 video submissions from 17 universities. Winners were selected for creativity, content, and quality of information; overall effectiveness of delivery; and technical quality. The two first place winners received $1,000, the two second place winners received $800, and the two third place winners received $500 in cash prizes. In the first year of this competition a Cal Poly student team placed first in the single topic category with their video titled "Bob, You've Been Phished" and one student received an honorable mention for his video titled "Password Strength & Security". The winning videos received national recognition at the EDUCASE website at http://www.educause.edu/SecurityVideoContest2006/7103.

## Internships

Internships provide a means for students to make the transition from college to career (AEJMC Conference Papers Listserv). The Computer Information Systems Department at Cal Poly established an internship class where students can gain college credit while working in the information systems field. Students sign up for a class where they provide information about their employer, immediate supervisor, job duties, number of hours worked, and the newness of the skills to be acquired during the internship. A simple formula is used to determine the number of units applied to the internship. The formula for total credit points earned = (H + D)* N where H = average hours worked per week during the quarter, D = depth of experience, and N = newness of experience. Table 4 below shows the number assigned to each variable in the formula.

**Table 4: Assigning Numbers to Formula Variables.**

| Formula Variable | Description | Number Assigned |
|---|---|---|
| Average hours worked per week (H) | Less 10 hours per week | 1 |
| | 10 – 19 hours per week | 2 |
| | 20 – 29 hours per week | 3 |
| | 30 – 39 hours per week | 4 |
| | 40 or more hours per week | 5 |
| Depth of Experience (D) | Data Entry/Operator (WP, SS, Access, etc.) | 1 |
| | Microcomputer Programmer (Access, Excel, etc.) | 2 |
| | Client Server/Computer Operator | 2 |
| | PC Technician | 2 |
| | Web Page Development/HTML Programmer | 3 |
| | PC (End User) Support | 3 |
| | Programmer/Systems Analysts/IT Audit Trainee | 4 |
| | Network Support/IT Security Support | 4 |
| | Multimedia Specialist/Asst. Web Manager | 4 |
| | Telecommunications Specialist/Web Manager | 5 |
| | Systems Analyst/IT Audit/IT Security | 5 |
| | CIS/MIS Management Trainee (large shop) | 5 |
| Newness of Experience (N) | Essentially the same as the previous quarter | 1 |
| | Majority of the experience is new (50% or more) | 2 |

| | | |
|---|---|---|
| | Experience is predominantly new (over 85% new) | 3 |

Table 5 below indicates the number of units students are eligible for once the calculation is completed. Take for example: John Smith has started working at his college campus averaging 20 hours per week at the Computer Help Desk. According to the calculation above for total credit points earned = (H + D)* N, John Smith would have earned 18 total credit points (3 + 3) * 3. Using Table 6 below you can see that 18 credit points earned equals 4 units of internship course credit. A student can only earn up to 16 units of internship credit during their academic career.

**Table 5: Determining the number of course credit earned.**

| Total Credit Points Earned | Units of Course Credit Earned |
|---|---|
| 2 – 5 points | 1 unit |
| 6 – 9 points | 2 units |
| 10 – 14 points | 3 units |
| 15 – 20 points | 4 units |
| 21 – 25 points | 6 units |
| 26 points or more | 8 units |

Students must submit three items to receive a grade in the internship class. First is a report with a brief description of the company's major objective, a listing of the major computer equipment the company has now and/or is planning to acquire in the near future, an organization chart showing where and how their department fits into the total organization, description of their specific duties and responsibilities, and a brief summary of their experiences during the past quarter stressing the new knowledge gained. The report also contains an evaluation of their internship experience directed at other students who may follow and a detailed description of their favorite project or system that they are working on or are interested in becoming involved in at their internship location.

The second item students are required to return are their immediate supervisor's evaluation of their performance. The criteria used in the evaluation are accuracy, appearance, attendance, cooperation, dependability, enthusiasm, initiative, interest, mental alertness, production, and tact. The performance evaluation criteria are shown in Table 6. Evaluators are asked to rate the intern compared to other new hires in the position by marking the appropriate column with a "√."

**Table 6: Supervisors intern evaluation criteria.**

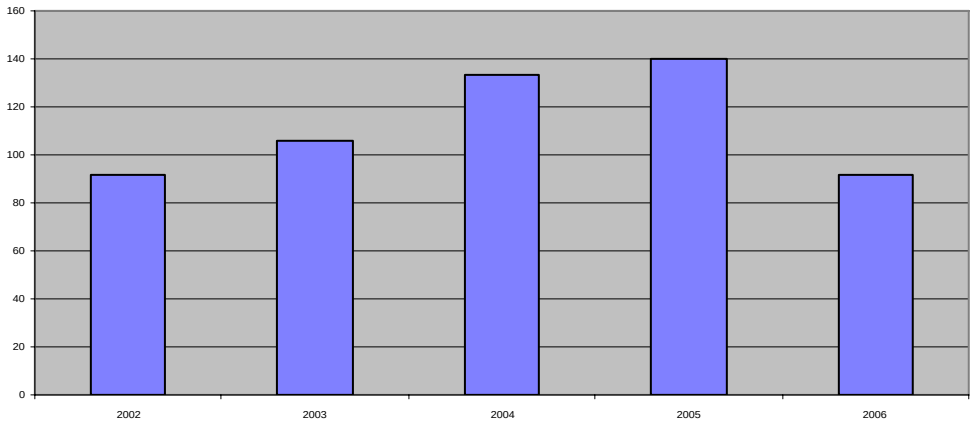
| CRITERIA | DESCRIPTION | OUTSTANDING | ABOVE AVERAGE | AVERAGE | BELOW AVERAGE |
|---|---|---|---|---|---|
| Accuracy | Exactness and thoroughness in performing tasks | | | | |
| Appearance | Grooming, poise, and general appearance | | | | |
| Attendance | Regularity and punctuality | | | | |
| Cooperation | Willingness to work with others | | | | |
| Dependability | Reliability and ability to follow through | | | | |
| Enthusiasm | Eagerness to learn: Aggressiveness | | | | |
| Initiative | Readiness to assume | | | | |

| | | | | | |
|---|---|---|---|---|---|
| | responsibility | | | | |
| Interest | Attention to details: Concern for firm's welfare | | | | |
| Mental Alertness | Ability to comprehend and carry out ideas or orders | | | | |
| Production | Quantity | | | | |
| | Quality | | | | |
| Tact | Discretion in dealing with others | | | | |

The last item required to assign a grade is a College of Business Internship Survey Form. The survey form has been in existence since Fall of 2001 and the results are presented below regarding the number of internships per year, number of internships per quarter, number of internships per class standing, compensation, hourly rates earned, internship source, internship satisfaction, permanent full-time or part-time position offered, and if accepted. Lastly, the number of internships related to information assurance activities are detailed. With all of this information available, one must keep in mind that students are not required to sign up for internship credit if they are working in the information systems field.

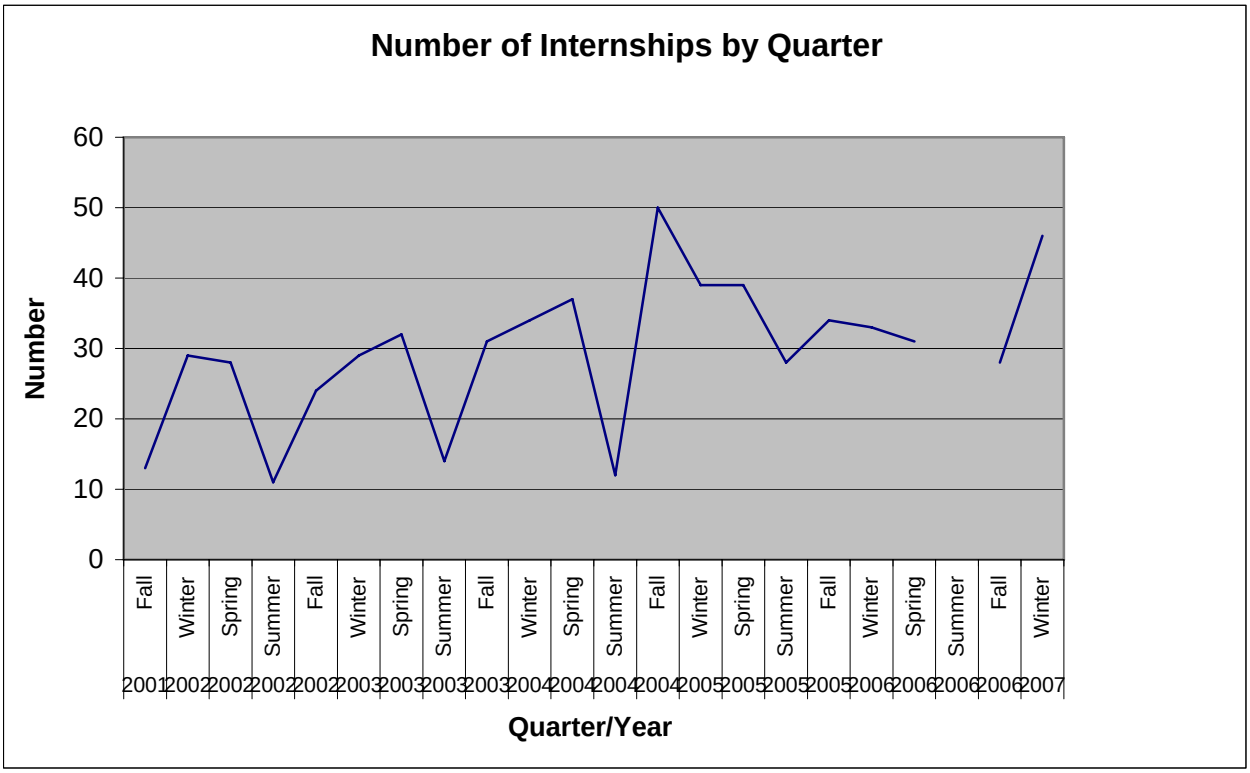
The number of internships has been growing as shown in Figure 1 below. In 2002, 92 students earned internship credit which grew to 106 in 2003 with a 15% increase, and 133 in 2004 with a 25% increase, and 140 in 2005 with a 5% increase. In 2006, summer quarter results were not included in the 92 internships earned. Based on summer quarters from the previous four years, anywhere from 12 to 25 internships could have been earned.

**Figure 1: Number of Internships by Year.**



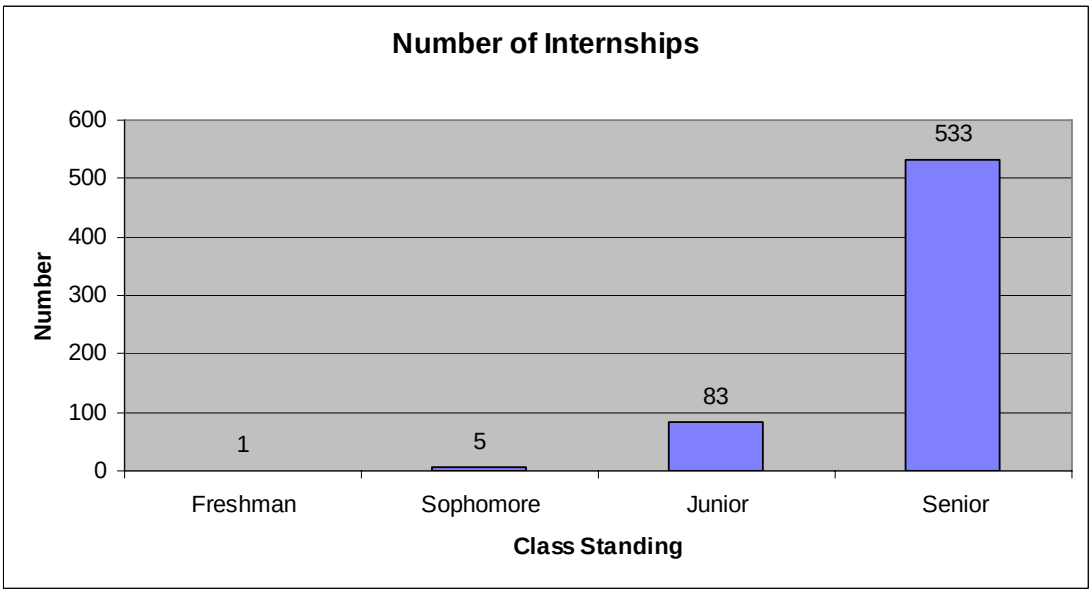

When analyzing the data by quarter from fall of 2001 through winter of 2007, as shown in Figure 2 below, it appeared that every summer quarter, the number of students earning internship credit declined. When investigating further into this unusual trend, it was discovered that students typically worked the internship during the summer quarter but did not receive credit until the following fall quarter. The shift in the quarter was directly attributed to the high cost involved with taking only one class in the summer quarter.

**Figure 2: Number of Internships by Quarter.**




When looking at the number of students receiving internship credit, the student's class standing is important. Figure 3 below breaks down the 622 internships from fall of 2001 to winter of 2007. As suspected, 533 internships or 86% were earned by senior students with only 13% by junior level standing students.

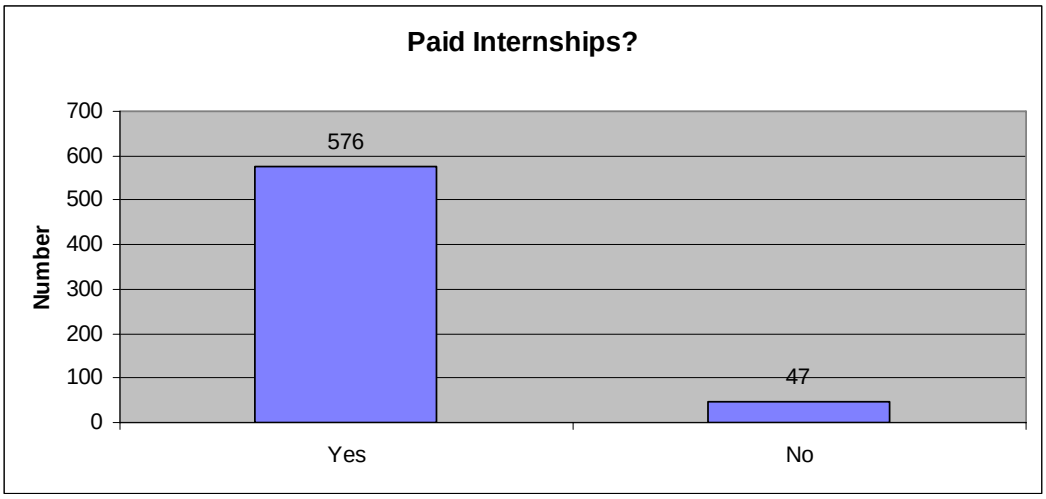
**Figure 3: Internships Grouped by Student Class Standing.**




Since the majority of students receiving internship credit are seniors, the next question is whether they are paid and how much. Figure 4 below indicates that 576 or 93% are paid internships. Most wonder why students would take

an internship with no compensation. The key to that answer lies with the students' interests, hobbies, and future goals. The latest unpaid internships were with the United States Secret Service and MTV.

**Figure 4: Internships Paid or Not Paid.**




For those students that are paid, as shown in Figure 5 below, the vast majority are earning between $11 and $20 with an overall average of $13.42. Considering that California minimum wage was $6.25 in 2001, $6.75 in 2002 to 2006, and $7.50 in 2007 (State of California, 2007), our students are averaging almost double the minimum wage based on the 2006 minimum wage.

**Figure 5: Hourly Internship Wages Frequency Distribution.**

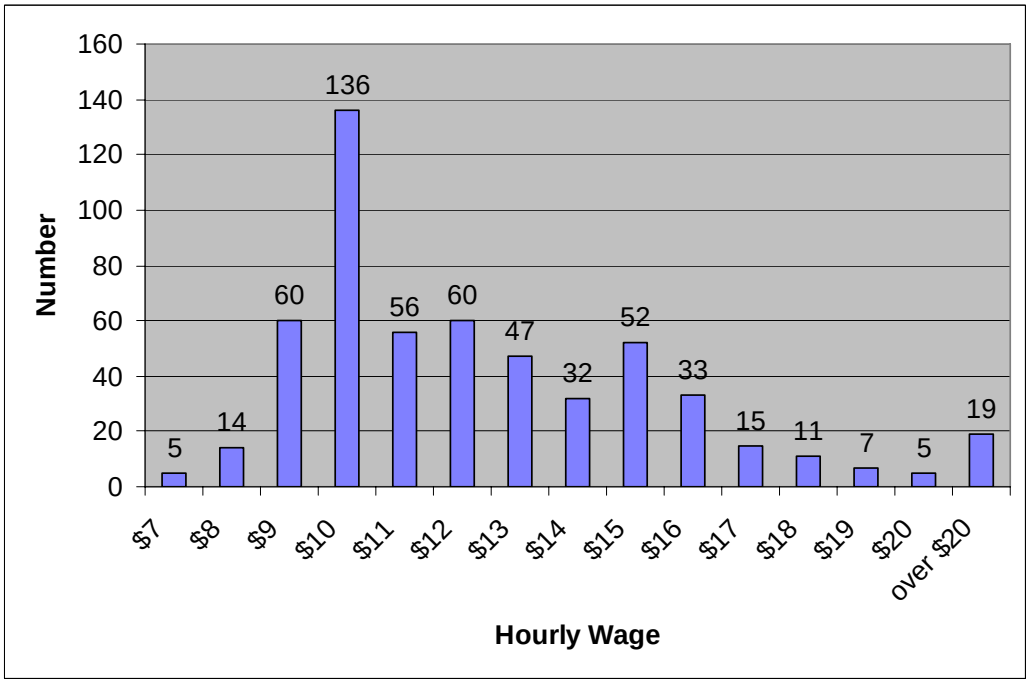
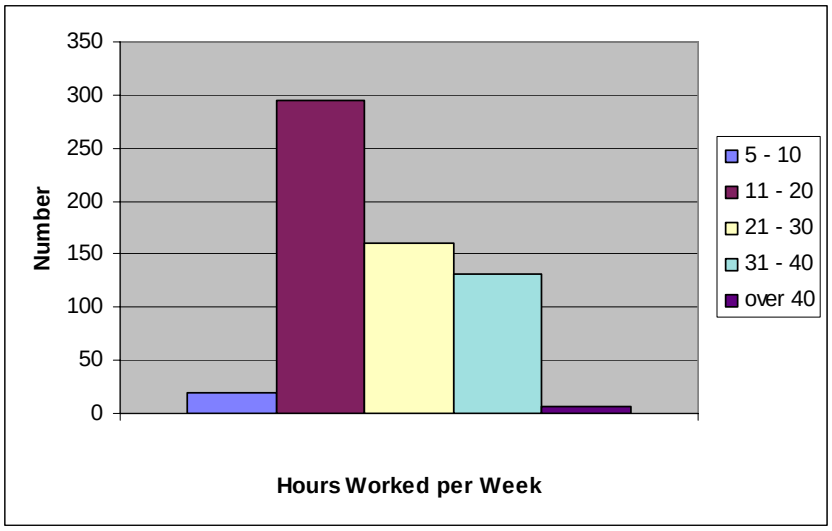



Figure 6 below shows the number of hours worked by students in their internships. The majority of students are working between 11 and 20 hours per week, the average being 21.6 hours per week. Consequently our seniors are

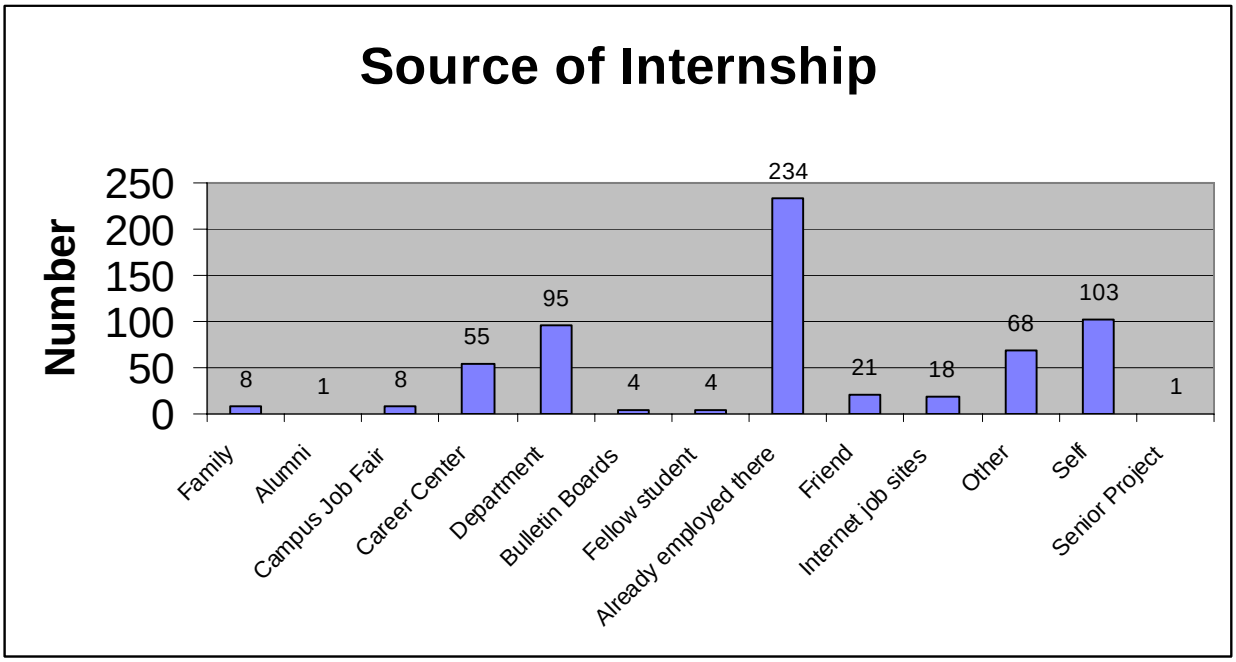
working almost 22 hours per week while taking the most rigorous classes in their major such as Senior Project mentioned earlier.

**Figure 6: Number of Hours Worked per Week Frequency Distribution.**



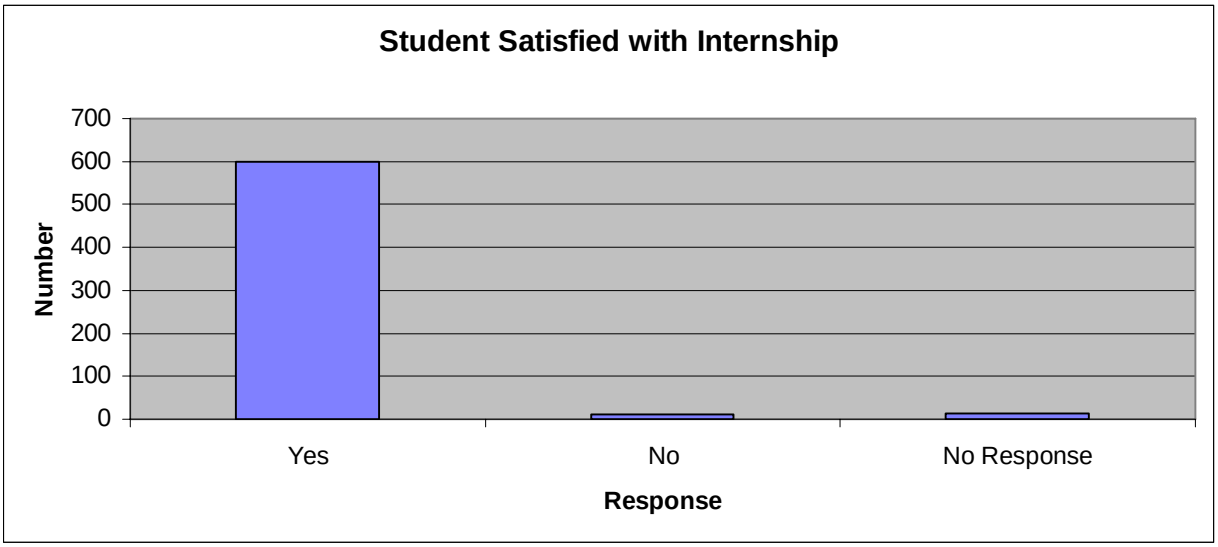

How do students get their internship? Figure 7 below indicates that the majority of students were already employed (38%) and that 17% (or 103) were found by themselves. The department itself only accounted for 95 or 15% and the University Career Center for 55 or 9% that combined together only accounted for 24% of the source for internships. In fact, the university funded resources only accounted for 163 or 26% of the student internships.

**Figure 7: Internship Sources.**



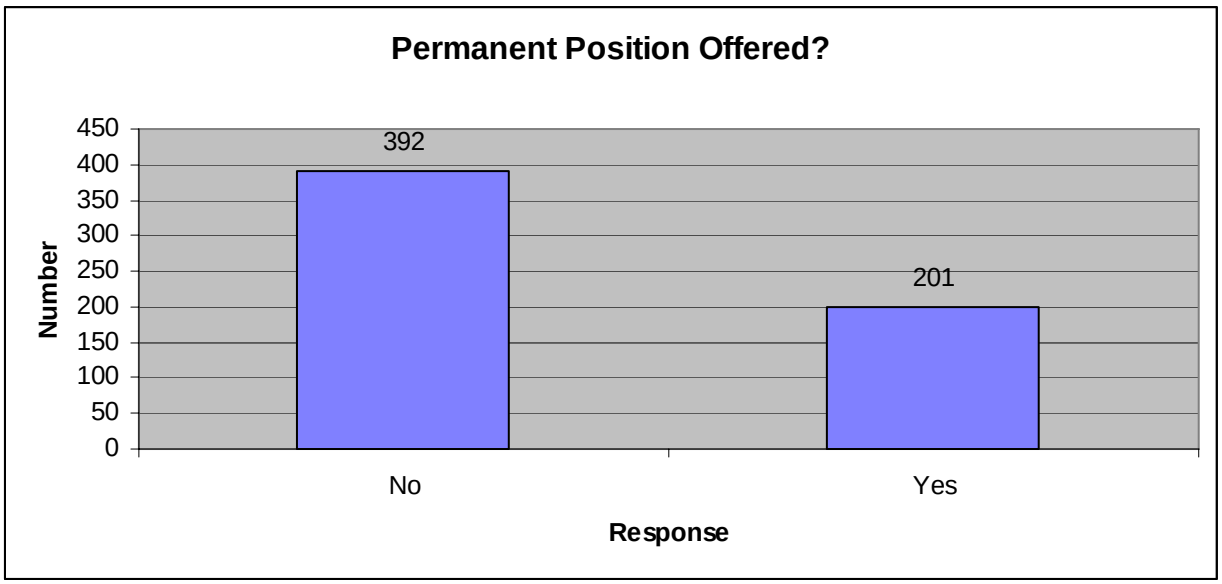
The internship allows students to gain valuable, marketable skills to place on their resumes. The College of Business Internship Survey Form asks students if they were satisfied with the educational experience. Figure 8 displays the responses indicating that 599 or 96% were satisfied with their internship experience.

**Figure 8: Internship Satisfied per Student Responses.**




The next question asked was whether their employer offered them a permanent position and if so was it full-time or part-time. Figure 9 below indicates that 392 or 66% were not offered a permanent position while 201 or 34% were offered a permanent position. One would think that the companies would be offering permanent positions since they have interviewed, hired, trained and mentored the intern. When informally asking students why they were not offered permanent positions, the common response was that they were not finished with their classes and would not be interested in a permanent position at that time. Other responses were that they could not continue with the internship due to the number of hours and its impact on their senior-level classes.

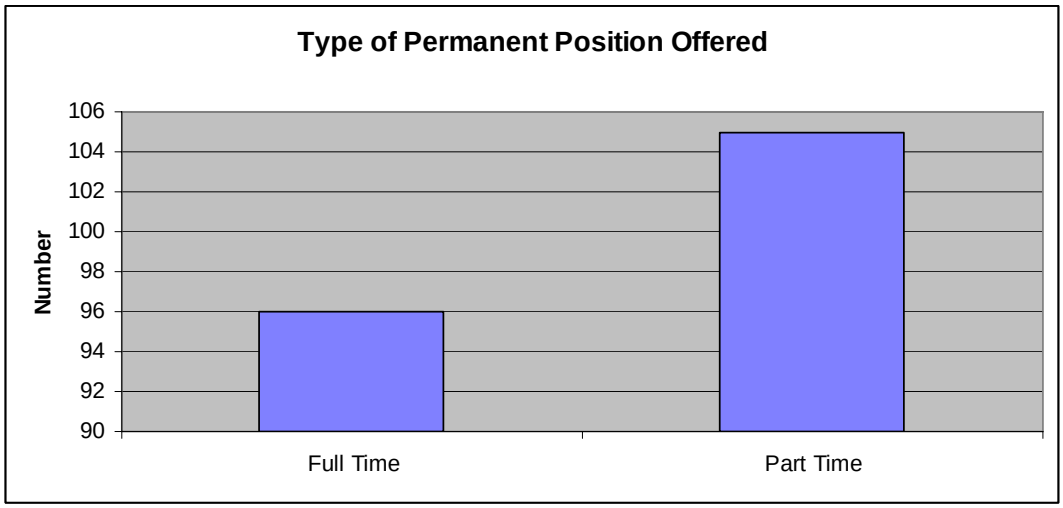
**Figure 9: Was a permanent position offered?**




For those students offered a permanent position, it was broken down further into whether it was a part-time or full-time position. Figure 10 below indicates that number of part-time positions offered was greater than the full-time

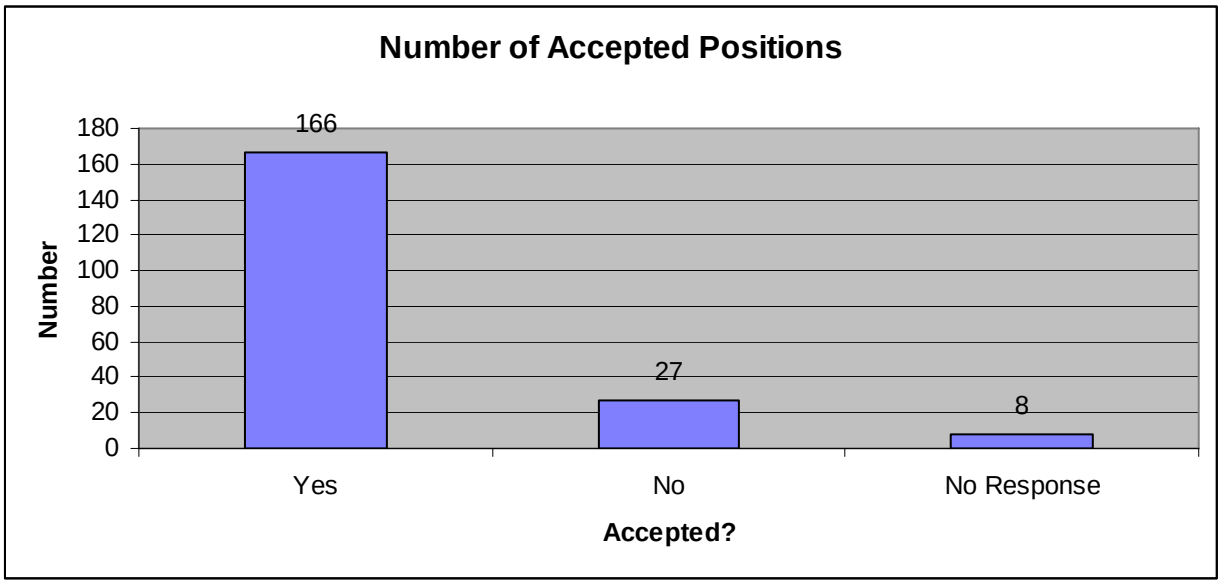
offerings. Part-time position offered was 52% as opposed to 48% of full-time offerings. Again this could be getting back to students having remaining classes and are only available part-time until they finished their degree.

**Figure 10: Type of Permanent Position Offered.**




The acceptance rate of the permanent positions offered was 83% or 166. In contrast only 13% were refused and 4% did not respond to the question. This statistics speaks to the value of the internship from the student's perspective. If the initial experience was not rewarding, students would not be accepting the permanent positions being offered.

**Figure 11: Accepted Permanent Positions.**

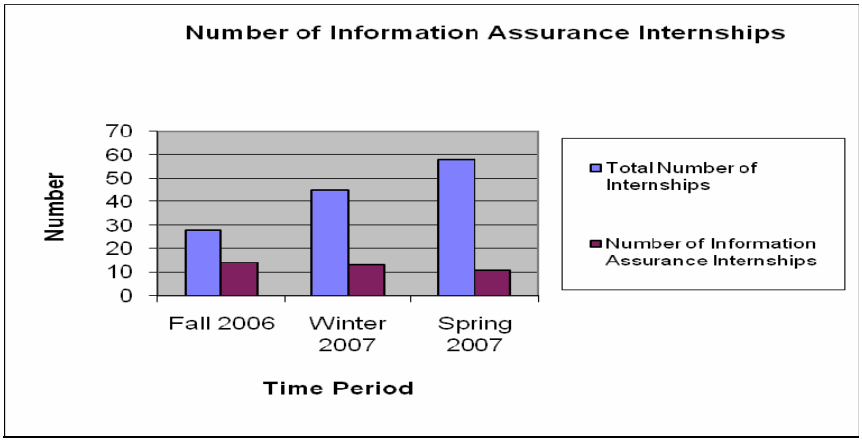



The last question is how many internships involved information assurance duties. Information assurance duties included security administration, SOX compliance, internal controls reviews, system backups, quality assurance, software testing, and secured web programming. Figure 12 compares the total number of internships to the number of information assurance internships. In Fall of 2006, approximately 50% of the internships included information assurance duties; in Winter of 2007, approximately 29%; and in Spring of 2007, 19%.

The factors influencing the number of information assurance internships were not studied in detail but could be attributed to the audit cycle for companies. Most companies' year end is December 31st which requires companies

to begin preliminary internal controls reviews in September to validate the financial statements. Once the year end review is completed, internal controls reviews could be fewer, however, the SOX compliance, systems backups, security administration, quality assurance, software testing, and secured web programming activities would remain constant.

**Figure 12: Number of Information Assurance Internships.**




As you can see from the survey data collected, internships are considered to be valuable in helping students transition from college to a career. "Despite the availability of good training, employers place a higher priority on actual experience in the application of technical skills. Therefore, no matter how well-trained, a worker without practical, hands-on work experience may not be considered for most jobs involving the newly acquired technical skills. This underscores the need for training program elements such as work-study and internships, and for providing training in a hands-on format that teaches technical skills as they would be used on the job". Some companies are hesitant hiring interns due to the training time and dollars involved without a guaranteed payback. However some employers with an internship program find that "these efforts developed student loyalty, helped tie students' academic work to the company's needs, and often paid off with the company retaining them in regular employment after they graduated from college" (U.S. Department of Commerce, 2003).

## CONCLUSION

In recent years many higher education institutions have worked on making their programs more "learning-centered", by focusing more on what students learn and how they learn it. The "learn-by-doing" approach of polytechnic institutions is inherently "learning-centered". This paper has discussed several ways that Cal Poly Pomona implements a "learn-by-doing" approach to information assurance education through senior projects, class projects, club activities, professional association activities, and internships.

There are many challenges in a hands-on approach to information assurance education. Developing, implementing and maintaining state of the art information assurance labs requires investment in equipment, software, facilities, lab support and faculty time and training. Senior projects require developing and maintaining relationships with internal campus and external community customers, and a curriculum that requires a capstone project. Class projects require supportive, creative teachers who are willing to include hands-on projects as part of class requirements. Club activities require students who are willing to donate significant amounts of time and energy to make events a reality. Successful execution of these activities strengthens department, program and university partnerships and reputation.

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