

EPICS: A Model of Service-Learning in an Engineering Curriculum

William C. Oakes, Edward J. Coyle and Leah H. Jamieson

Purdue University

Abstract

Engineering Projects in Community Service — EPICS — is a service-learning program that was initiated at Purdue University in the Fall of 1995. Under this program, undergraduate students in engineering earn academic credit for long-term team projects that solve technology based problems for local community service organizations. The program has grown to include 20 project teams with approximately 250 students participating during the 1999 academic year.

Each EPICS project team consists of ten to fifteen students. The teams are interdisciplinary including students from Electrical, Computer, Mechanical, Civil, Aerospace, Industrial and Materials Engineering as well as from Computer Science, Chemistry, Sociology, Nursing, Visual Design, English and Education. The teams are vertically integrated - each is a mix of freshman, sophomores, juniors and seniors - and a student can participate in a project for up to three and a half years. The continuity provided by this structure allows projects to last for many years. Projects of significant size and impact are thus possible.

The goals of the EPICS program include: providing students with multi-year, team-based, design and development experience; teaching students, by direct experience, how to interact with each other and with customers to specify, design, develop and deploy systems that solve real problems; and showing engineering students how their expertise can benefit even the most disadvantaged members of their community.

A national EPICS program is being initiated to expand this highly successful service learning model. Georgia Institute of Technology, University of Wisconsin and the University of Notre Dame will partner with the existing program at Purdue University to form local teams at their respective institutions as well as to network teams of students at the different institutions. These networked teams will be able to collaborate on issues at a regional or national scale.

Introduction

Undergraduate students in engineering face a future in which they will need more than just a solid technical background. In setting the goals for any system they are asked to design, they will be expected to interact effectively with people of widely varying social and educational backgrounds. They will then be expected to work with people of many different technical

backgrounds to achieve these goals. They thus need educational experiences that can help them develop these skills.

Community service agencies face a future in which they must rely to a great extent upon technology for the delivery, coordination, accounting, and improvement of the services they provide. They often possess neither the expertise to use nor the budget to design and acquire a technological solution that is suited to their mission. They thus need the help of people with strong technical backgrounds.

The Engineering Projects in Community Service (EPICS) program provides a service-learning structure that enables these two groups to work together and thereby satisfy each other's needs. This structure supports long-term projects in which teams of undergraduates in engineering are matched with community service agencies that request technical assistance. Under the guidance of faculty in engineering, these EPICS project teams work closely over many years with their partner community service agencies to define, design, build, and deploy the systems the agencies need. The results are systems that have a significant, lasting impact on the community service agencies and the people they serve.

Through this service, the EPICS students learn many valuable lessons in engineering, including the role of the partner, or "customer," in defining an engineering project; the necessity of teamwork; the difficulty of managing and leading large projects; the need for skills and knowledge from many different disciplines; and the art of solving technical problems. They also learn many valuable lessons in citizenship, including the role of community service in our society; the significant impact that their engineering skills can have on their community; and that assisting others leads to their own substantial growth as individuals, engineers, and citizens.

The Phases and Structure of EPICS Projects

Each EPICS project involves a team of eight to fifteen undergraduates, one or more community service agencies, and a faculty or industry advisor. Each team is vertically integrated, consisting of a mix of freshmen, sophomores, juniors and seniors. Each team is constituted for several years -- from initial project definition through final deployment -- with students participating for several semesters. This structure enables long-term projects. Over time, each project has five phases: Finding Project Partners, Assembling a Project Team, Project Proposal, System Design and Development, and System Deployment and Support.

Phase 1 - Finding Project Partners: Each EPICS project addresses the technology-based problems of one or more service organizations in the local community. Agencies with appropriate problems must therefore be found.

When planning for the EPICS Program started in the Fall of 1994, we were able to contact many different service agencies at the same time by making a presentation about the program and its goals at the monthly meeting of the directors of all local United Way agencies. This single presentation led to many discussions with individual agencies and a long list of potential projects.

From this list of potential projects, those best suited for the EPICS Program were selected. Projects are selected based on their:

- *Significance* -- not all projects can be undertaken, so those that should provide the greatest benefit to the community are selected;
- *Level of Technology* -- projects must be challenging to, but within the capabilities of, undergraduates in engineering;
- *Expected Duration* -- although projects may have components that can be completed in a semester or less, each project must be long-term, requiring two or more years of effort from a team of approximately eight undergraduates. Since the first round of projects that grew out of the United Way presentation, the source of new projects has been varied. Faculty has initiated some projects. Students have suggested others. As the program has become known in the community, several projects have been proposed by local community service organizations.

Each year, new projects are selected by the EPICS faculty, using the significance, level of technology, and expected duration criteria. From five initial projects in Fall 1995, the program has grown to seven projects in Fall 1996 and to twelve in Fall 1997. The seven 1996-97 projects are summarized in Table 1.

Once a project has been selected for the EPICS Program, the service agency that will be directly involved is designated the *Project Partner*.

TABLE 1
Summary of 1999-2000 EPICS Projects

-
1. ***Project Title:*** Automated Assistance Center ***Project Partner:*** Lafayette Crisis Center ***Tasks:*** Design stand-alone kiosks that will provide information about community services to people in need of assistance. Incorporate means of contacting appropriate agencies. ***Impact:*** Improved access to community services. ***Facts:*** Begun fall 1995, Disciplines: EE, Comp E, ME, Sociology, CS.
 2. ***Project Title:*** Habitat For Humanity ***Project Partner:*** Tippecanoe County Habitat for Humanity ***Tasks:*** Design energy management systems to minimize home operating costs. Develop new construction techniques and investigate new construction materials. ***Impact:*** More energy-efficient housing for Habitat families.
 3. ***Project Partner:*** Tippecanoe County Historical Association ***Tasks:*** Develop multi-media and electro-mechanical systems for on-line storage and interactive presentation of historical information. ***Impact:*** Improved access to historical information. ***Facts:*** Begun fall 1997, Disciplines: EE, Comp E, CS, ME, Photography.
 4. ***Project Title:*** Homelessness Prevention Network ***Project Partners:*** Ten Agencies of the Tippecanoe County Homelessness Prevention Network. ***Tasks:*** Design and implement a centralized database that allows the agencies to coordinate their services, track their clients,

and assemble accurate reports without violating clients' confidentiality. **Impact:** Improved continuity in serving the homeless; more accurate understanding and reporting of the scope of the homelessness problem in Tippecanoe County. **Facts:** Begun fall 1995, Disciplines: EE, Comp E, CS, Sociology.

5. **Project Title:** Speech-Language and Audiology Clinics **Project Partner:** The M. D. Steer Audiology and Speech-Language Center **Tasks:** Integrate a speech recognition system with computer graphics and games to encourage language development. Design and build a working model of the vocal system, for clinicians to use in educating laryngectomy patients. Automate calculation of speaking rate from clinical sessions. **Impact:** New services for the clinic's client; improved feedback to speech clients. **Facts:** Begun fall 1995, Disciplines: EE, Comp E, CS, ME, IE, Audiology.
6. **Project Title:** Wabash Center Children's Services (2 projects) **Partner:** The Wabash Center Children's Services **Tasks:** Develop electro-mechanical toys and play environments for children with physical disabilities. **Impact:** Expanded capabilities and control of their environment for children with physical disabilities. **Facts:** Begun fall 1996, Disciplines: EE, Comp E, CS, ME, IE.
7. **Project Title:** Imagination Station **Partner:** Imagination Station – Local Children's Museum **Tasks:** Develop systems to aid in science, mathematics and technology education. **Impact:** Improved, interactive displays to interest youth in science, math and engineering. **Facts:** Begun fall 1997, Disciplines: EE, Comp E, ME, MSE, IE, CS, Visual Design, Sociology
8. **Project Title:** Happy Hollow Elementary School **Partner:** Happy Hollow Elementary School **Tasks:** Develop systems to aid in science, mathematics and technology education. **Impact:** Improved educational resources for the community. **Facts:** Begun fall 1997, Disciplines: EE, Comp E, ME, MSE, IE, CS, Visual Design, Sociology, Education.
9. **Project Title:** Indiana Division of Families and Children **Partner:** Indiana Division of Families and Children **Tasks:** Develop a centralized database to help the four service agencies coordinate their activities and share information. Develop custom palm-top software to aid service personnel visiting families. **Impact:** Improved and less-expensive social services for at-risk children and their families.. **Facts:** Begun fall 1997, Disciplines: EE, Comp E, Sociology
10. **Project Title:** Klondike Elementary School **Partner:** Klondike Elementary School **Tasks:** Design of custom educational software, sound systems, and multimedia tools for education. **Impact:** Improved educational resources for the community.. **Facts:** Begun fall 1997, Disciplines: EE, Comp E, ME, CS, Education.
11. **Project Title:** Office of the Dean of Students **Partner:** Purdue University's Office of the Dean of Students **Tasks:** Design classroom furniture for physically handicapped college students; develop closed-captioning systems for deaf and hard-of-hearing college students...**Impact:** Improved access to education for physically disabled and hard-of-hearing students.. **Facts:** Begun fall 1997, Disciplines: EE, Comp E, ME.
12. **Project Title:** Constructed Wetland **Partner:** Purdue Department of Forestry and Natural Resources **Tasks:** Develop and construct a test wetlands area to clean up runoff from cattle,

dairy and swine farms to treat creek water **Impact:** Improved water quality. New techniques for mitigating agricultural runoff. **Facts:** Begun fall 1998, Disciplines: CE, EE, IDE, Chemistry, Biology

13. **Project Title:** Discovering Engineering Careers **Partner:** Purdue Office of the Dean of Engineering and local K-12 schools **Tasks:** Develop portable, hands-on demonstrations of engineering principles and practice that will spark interest in engineering careers among elementary, middle, and high school students **Impact:** Helping youths make decisions about high school course selection, attending college and career choices. Increased awareness of engineering and interest in engineering among K-12 students and their teachers. **Facts:** Begun fall 1998, Disciplines: CE, EE, Comp E, IDE, ChE, ME, IE, Sociology, Education
 14. **Project Title:** Wabash Center, Greenbush Industries **Partner:** Wabash Center, Greenbush Industries **Tasks:** Develop mechanical and electromechanical fixtures to aid individuals with disabilities in doing basic manufacturing and packaging tasks. **Impact:** Improved working conditions for disabled adults **Facts:** Begun fall 1998, Disciplines: ME, IE, EE.
 15. **Project Title:** Lafayette Adult Reading Academy **Partner:** Lafayette Adult Reading Academy **Tasks:** Design software and hardware systems to help children and adults learn to read and to assist people in learning English as a second language. **Impact:** Improved educational opportunities for the community **Facts:** Begun fall 1998, Disciplines: Comp E, EE, CS, ME
 16. **Project Title:** Columbian Park Zoo **Partner:** Columbian Park Zoo **Tasks:** Develop and construct multimedia educational center for the local zoo **Impact:** Improved educational resources for the community. **Facts:** Begun fall 1999, Disciplines: ME, EE, Comp E, CS, Biology, Animal Science.
 17. **Project Title:** Institute for Women and Technology **Partner:** Institute for Women and Technology **Tasks:** Develop and construct prototypes of technology that better serves the needs of women and families **Impact:** Improved use of technology for women. **Facts:** Begun fall 1999, Disciplines: Comp E, EE, ME, CS, Communications, and English.
 18. **Project Title:** Classroom Learning Technologies **Partner:** Office of the Dean of Education and local K-12 schools **Tasks:** Develop and implement improved ways for educational classrooms to utilize technology in an affordable manner **Impact:** Improved use of technology in K-12 and college classrooms **Facts:** Begun spring 2000, Disciplines: Comp E, EE, ME, Education, CS.
 19. **Project Title:** Information Management Systems **Partner:** EPICS Teams **Tasks:** Develop and implement improved database systems to improve the operation of EPICS teams and allow the program to continue to grow to meet the community needs **Impact:** Improved production from EPICS teams in meeting community needs **Facts:** Begun spring 2000, Disciplines: CE, EE, Comp E, ME, Mgmt, CS.
-

Phase 2 - Assembling a Project Team: Once a project and Project Partner have been identified, a student team is organized. This is done by advertising the project in undergraduate classes and on the World Wide Web. Eight to fifteen students are chosen for each *Project Team*. Depending on the needs of the Project Partner, teams may reflect a single engineering discipline or may be multidisciplinary, including students from two or more engineering fields.

The team must be *vertically integrated*: it must be a mix of freshmen, sophomores, juniors and seniors. Each student is requested to participate in the project for as many semesters as possible. The combination of a vertically integrated team and long-term student participation ensures continuity in projects from semester to semester and year to year. Projects can thus last many years if new students, especially sophomores, are recruited for the project as team members graduate. In the first two years of operation, 124 students have participated in the EPICS Program. Retention has been excellent. Based on registrations for the Fall 1995, Spring 1996, Fall 1996, and Spring 1997 semesters, 74% of the students who were available to return to the program in the following semester (i.e., were not graduating or off campus on a co-op assignment) did so.

Phase 3 - The Project Proposal: During the first semester of a project, the Project Team meets several times with its Project Partner and the EPICS faculty to define the project and determine its goals. During this phase the Project Team learns about the mission, needs, and priorities of the Project Partner. A key aspect of this phase is identifying projects that satisfy three criteria: they are needed by the Project Partner, they require engineering design, and they are a reasonable match to the team's capabilities. Also, to ensure that the students build confidence and the Project Partners see progress, the teams are encouraged to pursue a mix of long-term and short-term projects. Short-term projects generally require only one or two semesters to complete; long-term projects take two or more years. This process of project definition culminates in a written proposal and presentation in the fourth week of the semester. The proposal is critiqued during a lab session, with detailed feedback provided in the areas of organization, content, technical approach, and writing. The proposal must be approved by the EPICS faculty and then be accepted by the Project Partner.

Phase 4 - System Design and Development: Starting from week five of the first semester of a project, the Project Team's goal is to produce a prototype of the hardware/software systems discussed in the proposal. Interaction with the Project Partner continues in order to ensure that the systems being designed and developed are as desired. The formal portion of this interaction takes the form of a written progress report and an oral presentation delivered by the Project Team to the EPICS faculty and the Project Partner at the middle and end of each semester. The progress reports must meet the same standards as the proposals. The Project Team demonstrates the current state of their systems to a team of EPICS faculty every five weeks for the duration of the project.

This phase of a project lasts as many semesters as necessary for the team to complete the project to the satisfaction of the Project Partner.

Phase 5 - System Deployment and Support: The ultimate goal of each Project Team is to deliver a system to the Project Partner. After fielding a prototype, the team must train representatives of the partner in the use of the system, collect feedback, and make any reasonable changes requested by the partner. One of the hallmarks of the EPICS Program is that the systems

designed and built by the students are deployed in the field, where they provide real, needed service to the community. It has been our experience that after a team fields a project, other projects are identified and the teams continue their relationship with the agency.

Goals and Preliminary Evaluation

Goals of the EPICS Program include providing students with multi-year, team-based design and development experience; teaching students, by direct experience, how to interact with each other and with customers to define, design, build, and deploy systems that solve real problems; and showing engineering students how their expertise can benefit their community.

The EPICS Program emphasizes a number of skills that students will need to become successful, both as engineers and as members of their community:

- **Technical Skills:** Each project is chosen to have significant technical challenges. The students have an opportunity to develop and use skills learned in the classroom on real problems.
- **Communications:** Each project requires written reports, oral proposal and progress presentations, oral communications with project partner and consultants, and intra-team communications.
- **Organizational skills:** Because the scope and size of a project will be much larger than would be possible in traditional courses (where much time is spent covering course material), students have to apply what they have learned to less well defined problems across a variety of disciplines. This experience should encourage the development of the students' analytical thinking and organizational skills.
- **Teamwork experience:** Because projects are large, teamwork is an essential component. Students learn that the outcome of their project depends on the efforts of every member of the team. They learn how to divide up a large problem, assign and schedule sub-tasks, and integrate the pieces into a working solution.
- **Resourcefulness:** The multi-class projects should encourage students to pursue non-traditional educational resources. Projects involve upper-class students in the process of guiding the less experienced students. Students are encouraged to learn from each other, as well as from the project partner and academic consultants who have experience related to the projects.
- **Resource management:** Each team develops a proposal for the equipment and space requirements for the project, and must take into account the resources of the project partner. As a result, students should understand that practical as well as theoretical issues must be addressed throughout the design and development process.
- **Sponsor awareness:** Projects are being drawn from local community service agencies. Sponsor satisfaction is an important criterion for judging project success. Hence, the projects increase the students' awareness of the importance of the customer in producing a high quality product.

- **Expanded awareness:** By dealing with people outside of the academic community, the students will be more aware of the world outside of Purdue that they are preparing to enter.
- **Professional ethics:** Professional conduct, both in relation to the project partner and within the team itself, is an essential component of successful projects. Students have to maintain an awareness of ethical principles while meeting the demands of the project.

Evaluation Data

Independent formative and summative evaluations of the EPICS Program have been conducted by Professor J. William Asher, of Purdue's Educational Studies Department. In assessing the students' attitudes towards the program, the formative evaluations have been especially useful. A majority of the students cite the opportunity to obtain "practical, real-world experience in engineering design" as their primary reason for participating in the EPICS Program. In every semester, however, a significant number of the students also identify the opportunity to do community service as a major factor in their EPICS participation. Many of the students report that they have done community service in the past, in activities such as tutoring, church work, scouting, soup kitchens, crisis hotlines, and volunteer work for Habitat for Humanity. To date, none of the students has reported prior experience that combines community service with engineering.

To complement the descriptive evaluations, we have collected evaluation data along the dimensions of the specific program goals. To date we have responses from 898 student evaluations, collected at the end of each semester since the Spring 1996. Each aspect was to be graded on a letter-grade scale, with "A=excellent, B=good/above average; C=average; D=marginal/below average; F=poor" with the option for "N/A" for "not applicable". In compiling the data, each "A" grade was assigned 4 points, each "B" 3 points, each "C" 2 points, and each "D" 1 point. Grades of "F" were assigned 0 points. "N/A" responses were not included in the summary statistics.

Table 2 shows the average for each category for each semester. *Ability to Work in a Team* and received the highest average score. *Communication skills* and *awareness of the customer in an engineering project* are the next highest with 3.2 and 3.18 respectively. The reduction in the overall rating in the spring of 1999 corresponds to an increase in the number of students enrolled. As a result of this increase, the average team size swelled to 18-20 students in many cases. Follow-up comments from the students indicated that these size teams were too large. As can be seen in the following semester, Fall 1999, the ratings increased when the team sizes were reduced to 10-15.

In addition to these evaluations, qualitative comments were also elicited. Table 3 shows a summary of the responses to the question of "What are the three most valuable things you have learning from being a part of the EPICS program". The responses were grouped in categories and then correlated with the course goals. The categories that correlated with the course goals are shown in the right column along with the number of responses for each category.

There were 202 total responses and it is interesting that almost all (191) indicated that teamwork was one of the most valuable things they learned. Communication skills are second with 99. It is also interesting that technical skills is third with 83 especially when compared to the numerical

responses where technical skills are rated the lowest. It may be that the students expect their technical skills to be used in ways similar to a traditional classroom. It may also be that students don't recognize that applying what they learned to a new problem is helping them develop their technical skills. It should also be noted that understanding the design process was included in the technical skills and is a separate category in the numerical evaluations.

Table 2. Student evaluation in response to the following: *Evaluate the impact that EPICS has had for you on _____*. Evaluation is on a 4-point scale with a rating of A corresponding to a 4.0.

	S96	F96	S97	F97	S98	F98	S99	F99	Total
Your technical skills	2.81	2.71	2.84	2.79	2.83	2.88	2.56	2.78	2.75
Your understanding of the design process *	-----	3.42	3.49	3.04	3.02	3.14	2.91	3.01	3.07
Your communication skills	3.37	3.30	3.43	3.11	3.14	3.32	3.04	3.22	3.19
Your ability to work on a team	3.60	3.47	3.57	3.30	3.30	3.43	3.21	3.29	3.34
Your resourcefulness	3.30	3.32	3.29	2.99	3.11	3.22	2.95	3.06	3.10
Your organizational skills	3.09	3.20	3.08	3.09	3.02	3.12	2.92	3.05	3.04
Your awareness of the community	3.24	3.36	2.96	3.02	2.97	3.16	2.80	2.94	3.00
Your awareness of the customer in an engr project	3.52	3.42	3.31	3.16	3.11	3.33	3.04	3.08	3.18
Your awareness of ethical issues	3.13	3.02	2.92	2.94	2.73	2.96	2.66	2.69	2.82
OVERALL EVALUATION	3.23	3.55	3.53	3.13	3.15	3.21	2.90	3.10	3.14
Number of responses	44	60	49	112	122	148	202	161	898

* Question not asked in Spring 96.

Most of the qualitative comments elicited from the students are very positive toward the program. Some representative quotes from the spring semester of 1999 include:

By far the beset engineering class I have had.

Great, I am now thinking about going into engineering outreach as a career, which is what my team does.

It has given me hope because how I see that engineering is not just math.

It has encouraged me to stay in engineering, DEFINITELY

It is interesting that EPICS takes us as close as any class program would to real life engineering problems

It's great to be able to work on real projects and get some practical experience.

I am more enthusiastic about engineering & EPICS has given me an idea of real life engineering.

The positive comments are validated by the retention rates of students in the program. Of the students who take EPICS for one semester, 77% return for a subsequent semester. This figure is adjusted to consider students who are on coop rotations and are not on campus the following

semester.

As with any program, however not all comments are positive. Most of the negative comments address the lecture requirement or growth issues.

Table 3. Responses to the question "What are the three most valuable things you have learning from being a part of the EPICS program"

Course Goals	Total Reponses	Type of comments (# of responses)
Technical Skills	83	Design process (35), Applying classroom knowledge to real problems (26), Technical Skills (21), Problem Solving (2)
Teamwork	191	Teamwork (151), Leadership (30), Accountability (5), Responsibility (3), Cooperation (2)
Communication Skills	99	Communication Skills (69), Presentation skills (13), Technical documentation (12), Writing reports (5)
Organizational Skills	68	Organizational skills (39), Time management (14), Long-term project development (8), Dealing with deadlines (7)
Resourcefulness	21	Resourcefulness/ingenuity (11), research (9), adaptability(1)
Sponsor Awareness	23	Customer Awareness (23)
Expanded Awareness	17	Community Awareness (12), Community Impact (2), Helping others (3)
Professional Ethics	4	Character assessment/ethics (4)

Lessons Learned

During the first five year of EPICS, it has seen tremendous support from the students, the university and the community as demonstrated by . Along the way, there have been many lessons learned. These include the topics listed below.

Lecture Requirement - When EPICS began, the lecture portion of the course served as a supplement to the topics the students received in their regular courses and also as an opportunity to provide skills the teams needed for their projects. As the program has grown and developed, problems surfaced with this model. One of the problems is that students enrolled for seven semesters are not interested in hearing the same subjects repeated. Also, with the growth in numbers of teams and diversity of students and projects, it is virtually impossible to use the lectures to supplement technical needs. The needs are simply too diverse.

One semester, the lecture requirement was changed so that only new students needed to attend lectures. This did not work very well and created an unhealthy division in the teams between new and returning students. Unfortunately, the new students then had the expectations that they

would "get out of the lectures". This created a backlash that is still being felt a year later for students who want to get out of these requirements.

The way these problems are being addressed is to restructure the lecture requirement and provide choices on the students' part. There are a few lectures with noteworthy speakers that are required by all, but most are optional. The students are required to attend 10 lecture units, but are allowed to substitute lecture alternatives called skill series. Examples of skill series include learning how to operate a mill or lathe, developing effective surveys and sessions on multimedia software. These have been very popular and we have found that students use this as a way to gain expertise needed for their projects and also as a broadening opportunity (e.g. computer engineering students learn about a mill). Each teaching assistant develops a skill series in his or her own area of expertise and we use university resources for additional options.

Growth - As can be seen from Table 2, the numbers of students in EPICS has grown significantly. This growth has created glitches in parts of the program as we learn how to scale practices that worked for a small number of teams. The amount of space that EPICS students have has not increased since there were 12 teams which has created some frustrations with less space per team. Although equipment was added to handle more students, this disruption of services during the semester was in itself a problem.

In following up with these comments, we have found that students are passionate about problems they perceive and very forthcoming. They like EPICS and want it to stay excellent or improve and thereby hold the administrators accountable for this.

Grading – During one semester a pass-no pass option was tried. This created a large disparity in work effort between graded and pass/no pass students. This experiment was deemed a failure and has not been repeated.

Integrated into the curriculum – As students from different departments become involved in EPICS, it is important that the EPICS credits substitute for core classes that will count for graduation, such as technical or design electives. There is a substantial difference in the level of support among faculty and students in departments where this is the case. Table 4 summarizes the departments where academic credit is given currently.

Take advantage of diverse experience – At the university, there is a wealth of expertise that can be tapped to help solve the real problems our students work on. Our experience has been that others in the university are very happy to help, especially when it is helping to solve community needs. This has led to relationships being established beyond our normal academic circles and has enhanced the ability of the project teams to be successful. to solve the community problems we are working on.

Integrating Freshmen – The integration of second semester freshmen onto the teams has met with mostly positive, but some mixed results. In the Spring Semester of 1999, there were 28 Freshmen involved in the teams with 26 responding to the course evaluation of the freshmen experience. 20 reported positive experiences while 6 reported negative experiences. Follow up with students has shown that they were more susceptible to negative team dynamics. Most of the negative reactions dealt with teams that did not integrate new members well. It was interesting that one of the big hurdles was convincing upper division students and faculty advisers that the

freshmen could be significant contributors.

Student voice – As the program has grown, we have appreciated the opportunities to hear the student voice. One way this has been done is through the establishment of a student advisory council that meets during the lecture hour. One representative per team is nominated to the council. This group has been instrumental in helping to define the recruitment and placement procedures for teams, lecture topics, growth plans and reporting procedures.

Industrial Advisors - The involvement of four professionals from the community has added a great deal of richness to the EPICS program. The students speak highly of their experience with the community advisers and practicing engineers bring a healthy perspective that helps the teams. There are still hurdles with the industrial advisers including allowing them to grade the students themselves. Another interesting twist is that one of the four advisers this fall received a promotion in the middle of the semester and moved.

Table 4. Summary of EPICS Academic Credits

Department/School	Max. credits toward graduation	How it counts	Course numbers
Electrical and Computer	9	Engineering elective, lab credit, and/or senior design	EE 290, 390, 490
Mechanical	9	Fr./So - Free elective Jr/Sr - 6 credits of technical and/or design elective	ME 283, 383, 483
Civil	6	Tech Electives (up to 6 credits in)	CE 296, 396, 496
Freshman	N/A	N/A	ENGR 170
Aerospace	3	1 Engineering Elective	Use the above courses
Liberal Arts	3	Social Ethics Core	SOC 497
Computer Science	-----	Elective	Use EE courses
Education	-----	Elective	EDCI 490

The National EPICS Program

The EPICS Program was created at Purdue University in the Fall of 1995. By the Fall of 1998, EPICS Programs were also underway at the University of Notre Dame and Iowa State University. This demonstrated that the EPICS program satisfied important educational and community needs and was therefore compelling enough to be adopted by other universities.

The existence of EPICS programs at several sites opened the possibility of addressing community and educational needs that extend beyond those of a university and its local community. Perhaps easiest way to see that this was true was to observe that several agencies that EPICS teams were already working with were national in scope. These included Habitat for Humanity, the Salvation Army, the Red Cross, and the YWCA. EPICS project teams working

with these agencies in different cities could address such national-scale problems as homelessness, sub-standard housing, and disaster relief.

One multi-site EPICS project, the Homelessness Prevention Network (HPN) project, was initiated in the Spring of 1998. It involves two EPICS teams, one at Purdue and one at Notre Dame. Both are working with a number of agencies in their home cities of Lafayette and South Bend, IN. The local goal for each team is to enable its partner agencies to share demographic and services-provided information about their clients. The agencies could then produce duplicate-free counts of homeless individuals and families, meaningful data on the use and effectiveness of services, and a record for each client that can be used for case-management across all agencies and all available services. The common goal of these two HPN teams is the sharing of data on homelessness between Lafayette and South Bend. Success at this task will enable city-to-city comparisons, help track migration patterns, and determine which services are the most effective. The extension of this project to national scope could provide the first accurate characterization of homelessness throughout the U.S. and lead to better-informed public policy in the area of homelessness.

The potential benefits of many different national-scale EPICS projects -- pursued by a national-scale coalition of EPICS sites -- led to the creation in September 1999 of the National EPICS Program. The universities currently participating in this program are Purdue, Notre Dame, Iowa State, the University of Wisconsin-Madison, and Georgia Tech. Seed funding and other support for this effort has come from the National Science Foundation and Microsoft Corporation. The first two national-scale projects will be the National Homelessness Prevention Network (NHPN) Project that is already underway and the National Habitat for Humanity (NHFH) Project that will begin in the Fall of 2000.

Conclusion

The Engineering Projects in Community Service Program has added a new dimension to the educational experience for engineering undergraduates at Purdue University. It represents the first program at Purdue that formally integrates service-learning into the engineering curriculum. Key features of the program include vertically integrated, multidisciplinary teams and multi-year participation. From the academic side, this structure provides students with the opportunity to be involved in all phases of the design process, from project definition through deployment, on projects that are large in scale. Moreover, the structure encourages an extended service-learning experience, with emphasis on providing a model of how engineers can use their technical skills to benefit the community. On the community side, the EPICS structure fosters a long-term relationship between project teams and the community service agency partners, and enables ambitious projects that can have a significant impact.

After five successful years, the EPICS program is continuing its development and growth. The plans for the Purdue program are to continue its controlled growth, although at a slower rate for the 2000 academic year as the National Program comes on line. The creation of national networks of teams will not only increase the ability of teams to tackle larger scale problems, but will provide participating students with an even richer educational design experience.

Further information about the Engineering Projects in Community Service Program is available at: <http://epics.ecn.purdue.edu/>

References

Dahir, M. (1993). Educating engineers for the real world, in *Technology Review*, Aug./Sept. 1993, pp. 14-16.

Engineering Deans Council and ASEE (1994). *Engineering education for a changing world*, report of the Engineering Deans Council and Corporate Roundtable of the American Society for Engineering Education. Available from the American Association of Engineering Education.

Honnett, E. P. & Poulsen, S. J. (1989). *Principles of good practice for combining service and learning: A Wingspread special report*. Racine, WI: The Johnson Foundation, Inc.

NSF Coalitions Programs [Online]. Available: www1.needs.org/coalitions/index.html [1997, July 2].

Authors

EDWARD J. COYLE is Professor of Electrical and Computer Engineering at Purdue University, where he is co-founder and Co-Director of the EPICS Program. He is a co-recipient of the American Society for Engineering Education 1997 Chester F. Carlson Award for Innovation in Engineering Education. He is a Fellow of the IEEE. His research interests are in the areas of computer networks, digital signal processing, and stochastic processes.

LEAH H. JAMIESON is Professor of Electrical and Computer Engineering at Purdue University, where she is co-founder and Co-Director of the EPICS Program. She is a co-recipient of the American Society for Engineering Education 1997 Chester F. Carlson Award for Innovation in Engineering Education for her work on the EPICS Program. Her research interests are in the areas of speech recognition and parallel algorithms. She is a Fellow of the IEEE.

WILLIAM C. OAKES is an Assistant Professor in the Department of Freshman Engineering at Purdue University, where he is a Co-Director of the EPICS Program. He is an active member of ASEE serving as an adviser to the Purdue Student chapter and on the board of the Freshman Programs Division. He was a recipient of 1993 ASME Graduate Teaching Fellowship and the 1997 ERM Apprentice Faculty Grant. He is the recipient of the 1999 Best Teacher Award for the Department Freshman Engineering and is an Indiana Campus Compact Faculty Fellow.