Project Summary of a K-12 Outreach with a Summer Program and a Mobile Laboratory

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Abstract:

This paper will describe and summarize a two-year project using hands-on activities to introduce K-12 students to Electrical Engineering and Electrical Engineering Technology and inspire and foster an interest in engineering, mathematics, and science. Two specific projects included in this initiative were:

- developing new summer hands-on workshops for students entering grades 5 through 10 through the 'Young Scholars' summer on-campus program, and
- deployments of the Mobile Electronics Manufacturing Line (MEML) to schools in the area, exposing additional students to electrical engineering / electrical technology with hands-on experiments. These deployments were coordinated with the help of K-12 teachers.

We were able to reach 111 students through our summer workshops as part of the Young Scholars program at IUPUI, and just over 800 students through deployments of the MEML.

The paper will summarize the efforts within the project, address funding, discuss results and emphasize lessons learned when approaching a large scale K-12 project. Many roadblocks were encountered over the two year period, and these lessons should prove valuable to anyone proposing such a project.

Introduction:

The overall objective of this program was to increase awareness and appreciation of electrical engineering and technology in K-12 students and teachers. It is widely accepted that hands-on activities make a very favorable impression on students: both of these projects had students and teachers engaged in hands-on activities in different areas of engineering, showing that these activities are fun and interesting[1]. The IEEE Foundation provided funding for this activity amounting to approximately $50k over a two year period. Other organizations contributed approximately $30k. It should be mentioned that the MEML lab already existed[2,3]: in other words, the funding was not to build or equip the MEML, but for deployments, operation and components for the MEML and course offerings for Young Scholars.

The Young Scholars program allows students to come to a campus and experience classes in the University setting. They can be exposed to many hands-on activities, and students consistently rate the technical classes as some of the highest of any available summer workshop in the Young Scholars program. This program was able to reach students from grades 5 through 10.

The Mobile Electronics Manufacturing Line (MEML) is a surface mount electronics manufacturing line contained in a 36-foot trailer, capable of being deployed to area schools or special events. Students touring the MEML see the operation in action, and have the opportunity to operate all of the equipment inside, building their own small electronic assembly. The objective of deploying the MEML is to engage students in a real world electronics manufacturing operation, where they build their own assemblies.

The students exposed to engineering and technology via these and similar projects should develop an appreciation for engineering early enough to (hopefully) influence their career choice - students (and their parents) who were involved in these activities stated that they loved the activities and parents have expressed appreciation to the instructors for explaining engineering to their children in a fun and exciting way.

Young Scholars

The Young Scholars program was established before the starting date of this grant and was quite successful. The technical portion of the program was named as one of the top three programs nationwide in the *IEEE-USA Precollege Education Project Competition*. We had a series of classes which were all full, and demand for more technical content in the program. The Young Scholars program is administered by the School of Education, not the School of Engineering and Technology.

The courses offered (and enrollments in) each course follows. Class enrollments were limited to 20 in 2001, and 15 in 2002. The courses for Summer 2001 were:

> Electronics I - (week 1) - *students entering grades 6 - 8*
> *attendance: 19*
> Do you like putting things together - or maybe breaking them apart to see how they work? We'll explore electronics, look inside of computers, and see how different hardware and software works. We will build web pages, and build some small projects which you can keep! We will also look at other areas of Engineering and technology. This class is intended for kids who have not taken Electronics in Young Scholars before. (Suitable for grades 6 and up).

Electronics Plus - (week 2) - *students entering grades 7 - 10*
attendance: 12
Continue with more Electronics - we will explore some areas in more depth. We will look at digital electronics design, computer programming, and computer simulation. Students also will build some small projects using surface mount technology. Don't know what these terms mean? That's OK - you will by the end of the week! This class is suitable for anyone grades 6 and up; if you have taken electronics before or not!

Technology for Kids - (both weeks) - *students entering grades 3 - 4*
attendance: week 1 = 10, week 2 = 7 Total: 17
This class is for kids who like to make things work or see how things work. We'll look at different areas of science and technology - electrical, mechanical and chemical projects, we'll build things you can take home - and we may get to take things apart too! For all kids, girls and boys!

Course descriptions and enrollments for 2002 follow:

ElectroFun for Senior Scholars - (week 1) - *students entering grades 8-10*
attendance: 12
ElectroFun for Senior Scholars! Learn about basic electricity & electronics with hands on projects and games. Includes lights, buzzers, computers, and fun projects you can build and explore! Great for girls and boys, no science background required!

Exploring Computers - (week 2) *students entering grades 7-10*
attendance: 14
Exploring Computers: (open for 7th graders also): We'll explore computers from the inside out - hardware and software. We'll look at taking apart & setting up computers, how to take care of them, writing Web pages, computer programming with Visual Basic and other interesting software, using computers to make & change pictures & sounds, and more!

Advanced Electronics: Doing Digital! - (week 3) *advanced students entering grades 8-10*
attendance: 8
Advanced Electronics: Doing Digital! open only for students who have taken a beginning course: This will be a project course, We will learn about digital electronics and design projects. This class will be geared toward the student who wants to learn how things work. There will be some research and homework required. Design a project, build it and see it work!

ElectroFun for Junior Scholars! - (week 2) *students entering grades 5-7*
attendance: 14

ElectroFun for Junior Scholars! Learn about basic electronics with hands on projects and games. Includes lights, buzzers, and even an optical car you can build and race! Great for girls and boys, no science background required!

Technology for Kids - (both weeks) - *students entering grades 3 - 4*
attendance: 15
This class is for kids who like to make things work or see how things work. We'll look at different areas of science and technology - electrical, mechanical and chemical projects, we'll build things you can take home - and we may get to take things apart too! For all kids, girls and boys!

The totals for both summer sessions were 9 sections with 111 students in grades 3 through 10[4]. We were able to do quite a few interesting activities in these classes, ranging from taking things apart - a favorite of students everywhere (although they did have to prepare a report on how the item worked, not just be destructive) to designing a "Get in Trouble Detector" which students designed, burned into a programmable logic device (PLD), and soldered.

Some Web pages from these classes on the Internet which can be seen at[5]:

http://www.iupui.edu/~scholars/

The main lesson for the Young Scholars program is also related to its strength as a summer camp program: the administration is done by another group. This does take care of a lot of the headaches of registration, drop off and pick up, shuttling classes around campus and finding college student escorts for students as they move from activity to activity. However, the School of Engineering and Technology was out of the loop when decisions were made that drastically cut the enrollment - raising fees, eliminating & combining classes to form larger classes. Some of these decisions certainly cut enrollment; for example, if a 3rd grade child was signed up for "Technology for Kids", and offered instead a choice of "Egyptian Storytelling" or come back next week, that child's enrollment may simply be cancelled. Since the engineering & technology courses are the cornerstone of the program and by far the most popular classes, most of our courses did run as scheduled.

Mobile Electronics Manufacturing Lab (MEML)

The Mobile Electronics Manufacturing Laboratory (MEML) is a unique instructional tool useful for introducing young students to opportunities in the Electronics Manufacturing industry. The MEML is a fully operational, surface mount technology (SMT) manufacturing line housed in a trailer, and can be

transported to middle and high schools throughout the state of Indiana and beyond. The laboratory is built to give students hands-on experience in operating equipment comparable to that found in a high-volume electronics assembly operation. Because it is a fully functional assembly line, it can also be used as a low volume or prototype development laboratory.

The MEML was developed as a joint project between the Purdue School of Engineering and Technology at IUPUI and the Naval Surface Warfare Center, Crane, Indiana. It was operated by the Navy for five years before its transfer to IUPUI.

The MEML is used for deployments to schools and events and a laboratory space for our Electronics Manufacturing class. Students in the manufacturing class operated the equipment and designed and programmed assemblies to use on the deployments.

The MEML was deployed 17 times over the two year period with just over 800 students participating in building electronic assemblies.

Most of the deployments were to schools in the Indianapolis area, or on-campus events for students from local K-12 schools. Some of the more interesting deployments included the following:

S "Curiosity, Confidence, Challenge! : A Conference for Girls on Careers in Math, Science & Technology" - 3/10/01 *72 female students*
Hosted by Marian College; sponsored by Sycamore School & Ruth Lilly Endowment
This deployment involved a faculty member and two female students, since the goal of the conference was to allow girls to explore different areas of engineering. 72 girls in six groups went through the MEML and built functional electronic assemblies.

S Hillside Middle School, Northfield, MI. - 5/21 - 5/23/02 *250 students, 6 teachers*
This deployment was initiated by an IEEE member who teaches 8th grade at Hillside Middle School. Mitch VanOchten saw an article on the MEML in the The Institute, an IEEE newspaper, and scheduled the visit. The school did extensive wiring to accommodate the MEML. Students toured and built assemblies for three days. The students and teachers were all very excited to see the operation, and we had excellent feedback.
One email relayed to me from a parent said,

> "I just wanted to drop you a note and let you know that the engineering demonstration that Holly attended yesterday made a big impression on her. She was so excited about what she learned that she called me at work as soon as she got home. She had thought that engineering was a "boring" career choice, but now she is all set to go to Purdue (at least this week). Hopefully this will translate to her math and science classes"

S Shepherd's Community Center - 7/18/02 *88 students, 10 adults*

Shepherd's Community Center is a shelter for at-risk youth. This deployment was part of a summer camp program for kids entering grades 1 through 10. These inner city kids are either at a very high risk of dropping out, or may have already dropped out of school.

There were many lessons learned through this part of the project. Of course, working with an existing mobile laboratory is a tremendous advantage.

Lessons learned - "What should I know before starting a similar program?"

Funding

The main issue for programs like these will always be funding; most other problems can be solved (or at least helped) by adequate funding. There are numerous papers, workshops, and presentations dealing with funding questions like how to apply, where to apply, etc. Some sources of funding that may be overlooked and should be explored are:

- Professional societies; remember to consider local chapters of these societies as well
- Local charitable organizations
- Local businesses - look especially for those companies that sponsor a few activities

Personnel

Our most significant problem was personnel. We had one of the three key personnel leave for a different job weeks into this project. This person was to take care of curriculum development, scheduling MEML deployments, and running the manufacturing line during deployments. This was a tremendous problem, as her responsibilities had to be assumed by other participants. We also had more trouble than originally anticipated using students to run the line during deployments, finding only two students who stayed with the project for months at a time. Some points to consider when looking at a similar project include:

<u>Plan on a worst-case scenario during project development</u>
What would happen to the plan that you are working on if a key participant leaves? If your project requires specific students, or students with special skills, what happens if those students are not available? These questions were two that we did not discuss during the development of the project - how could such a thing ever actually happen? Unfortunately, it did happen, and it would have been very helpful if we had discussed the possibility before the start of the project. We were quite fortunate that we had a different department taking care of the administration of the Young Scholars program and didn't have to deal with most issues during the change in leadership of that program; however, administration of a project must certainly be considered for any project plan.

Be sure that all participants are behind the project if it materializes
We were successful with this for the most part, but this is an issue that must be considered while planning a project to avoid problems down the road.

Equipment & Supplies

Probably the only disadvantage to using a mobile laboratory that already existed was the repair and upkeep of equipment that we had not originally purchased. We were very fortunate to have two lab assistants who were willing to help us tear apart and repair equipment when necessary. Issues which should be considered during project planning include:

How will necessary equipment be repaired if necessary?
We had extensive manufacturing experience in our department and available to us from the outside. Had this help not been available, we wold have had tremendous problems. Be sure to consider the answer to this question.

Look for donations of equipment and supplies when possible
We were able to receive donations for the Young Scholars program, especially for labs where items were disassembled. We also received a lot of promotional items from area companies to pass out to the students. However, the donations would not have come in if we had not asked - be sure to ask when the opportunity presents itself.

Publicity

Most of the lessons learned fall under this area.

Look for free publicity opportunities
We were able to find publicity for free from a number of sources. This free publicity was far more effective than a quarter-page ad we paid for advertising the Young Scholars program. Some suggestions:

- Look in K-12 schools for their newsletters: We found that individual schools are usually willing to include information you supply in their newsletters. You may have to contact schools individually rather than going through an administration office, and it is very helpful to have an ad or a printout of the announcement with you when you ask.

- Check with local chapters of professional societies. We were able to publicize with the Central Indiana Section of the IEEE through a number of their publications, and through the national press of the IEEE[6,7].

- If you plan a specific event, check with local television and radio about their Community Calenders, an opportunity to advertise for free.

- Look at a diverse range of customers: we were able to deploy to a summer camp for disadvantaged youth, a group of kids usually not addressed by a special program run by a University.

Be sure that the message reaches the appropriate audience, *and* that they understand it

We identified the appropriate contact through the local school system to publicize the opportunity to have the MEML visit area schools. We prepared a letter explaining the deployment and had it sent to 10-15 schools, then distributed to each science and math teacher. Out of the 30-40 teachers who eventually received this information, we received two inquiries, a serious disappointment. The problem was that the mission and operation of the MEML, surface mount electronics manufacturing, was a topic that the teachers were not familiar with. We hosted a group of area guidance counselors in the MEML, and when asked if they knew the differences between engineering and technology, one counselor said that she wasn't really sure what engineering was, let alone the differences between the two. In other words, be sure that your material is written to the level of the reader that you would like to reach. K-12 teachers were more interested in understanding how this would affect their classrooms directly instead of what the students would see in the MEML. The recommendation in a similar case would be to run the letter by a few teachers to get their input on how the offer should be explained.

Have a plan to deal with all types of inquiries

Once an opportunity presents itself to your customers, they will have requests that may not fit your schedule. For example, should the MEML be deployed (a significant effort) for 5-10 students? Could we deploy out of state? What about the deployments that are set up, then cancelled at the last minute? Any similar project should have these issues considered. If it is possible to establish relatively firm guidelines regarding when the resources should be used, it will certainly prove valuable down the road. Although, of course, it may be impossible to anticipate every type of inquiry before the project begins.

Conclusion

Projects like those described here can be extremely rewarding, and can even far exceed your original expectations. Like any other projects, proper planning techniques will more fully ensure success of the project.

When planning a project, especially as the primary participant, be sure to address the difficult questions, or worst-case scenarios during the project planning stages. Also, during project planning or even during the administration of the project, seek out unique opportunities for matching or additional funding, for free publicity, or for donations of necessities. Many unique opportunities exist - the trick is to find the best answers to the problems that present themselves.

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