A HANDS-ON APPROACH FOR K-12: GETTING INDUSTRY INVOLVED

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Abstract *¾ How does one best reach today's students and convince them to be tomorrow's engineers and scientists? Should we make them sit in lectures, watch movies, or read books? Or should we introduce them to technology professionals and have these role models engage them in hands-on activities? This paper analyzes the motivation for classroom visits, suggests activities in the classroom, and includes a detailed example of one effort by Sony Ericsson Mobile Communications, Inc., to increase the pool of technical workers in the next decade.*

Index Terms ¾ Hands-on Science and Engineering, K-12 Education, Mobile Phones, Cellular.

INTRODUCTION

Science, mathematics, engineering, and technology are essential to the future of America's global competitiveness [1]. Today's teachers need to ensure they expose students to these topics, but many lack knowledge of engineering and technology development to adequately convey detailed information. Also, those teachers who have studied science and math extensively have not practiced these subjects in the business environment. What are needed are mentors for the students, or at least role models. However, these role models must ensure that their contact with the students is meaningful, not just a boring talk. It is generally accepted that people learn best by doing. This extends to students in the classroom as well [2]. Perhaps the best way to expose students to the engineering and technology world is to mix concepts with a hands-on activity.

The school system budgets today are stretched. Now, more than ever, the business community must step forward to assist the educational system. The business community must offer mentors and financing to help schools prepare today's students for tomorrow's professions.

This paper describes the activities of Sony Ericsson Mobile Communications, Inc. in a local K-12 outreach program. Specifically, it describes the history of involvement and the development of educational activities that can be used in schools. Sony Ericsson created a kit that can be carried to schools to demonstrate the engineering required to design and manufacture a mobile phone. The kit contains presentation transparencies, teacher/presenter guides, fifteen mobile phones, and tools needed to open and examine the mobile phones.

The major results of the kit and presentation/activities are:

- The materials can be used by teachers or by practicing engineers.
- Children learned the difference between a scientist, an engineer, and a manufacturing worker.
- Children learned that there is a lot of work needed to design and manufacture everyday products.

Children enjoyed the hands-on approach, and took great pride in being able to disassemble and correctly reassemble the phones.

The ideas and materials described in this paper have been used with approximately 500 fourth grade students in North Carolina with excellent results. It was also used in two shopping mall activities during Engineers Week with 200 children and adults with good results. A more complex variation has been used with 200 Computer Engineering sophomore students at North Carolina State University with good results.

As a special treat for attendees of the session, the presenter of this paper will hand out sample phones that the attendees may keep. With as much time as is available, the presenter will conduct a very brief example of a hands-on activity.

HOW TO INVOLVE INDUSTRY PROFESSIONALS

The authors of *Science for All Americans* [1] state, "The terms and circumstances of human existence can be expected to change radically during the next human life span. Science, mathematics and technology will be at the center of that change causing it, shaping it, and responding to it. Therefore, they will be essential to the education of today's children for tomorrow's world." This tells us that the future of America's global competitiveness depends upon a well-educated, technologically literate work force. The key to developing this workforce lies in our ability to teach our youth about the importance of science and technology in our rapidly changing, rapidly shrinking world.

In mid-2000 Sony Ericsson assessed their employment situation in technology-rich Research Triangle Park, NC. Their observations were that they saw explosive science and technology growth. Approximately 67% of new hires were engineers. Sony Ericsson and other NC companies were having difficulty finding qualified employees for full time engineering/scientific positions. They realized they must assist in increasing the pool of scientists and engineers, at least at the local level.

Sony Ericsson became an active member of the North Carolina Business Committee for Education (NCBCE).

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NCBCE is a catalyst for systemic change and continuous improvement in public education. NCBCE involves business in results-oriented, self-sustaining, state and local initiatives to prepare all North Carolina students to be nationally and globally competitive for employment and lifelong learning. They believe that an educational system built upon high performance principles is linked to positive long-term economic development and quality of life. Although the business community has immediate needs, they see the importance of long term investments.

BLUEPRINT FOR GRASS-ROOTS INVOLVEMENT

Sony Ericsson was interested from a business community perspective, but could they participate at a lower, "grass roots" level? The answer was, of course, yes, and the chosen venue was an organization called *Scientists in the Classroom* [3]. This non-profit organization pairs teachers with science and engineering professionals. Sony Ericsson helped *Scientists in the Classroom* by signing up many engineers for their program and providing funds.

The following is the process followed to involve Sony Ericsson engineers in the community. This process could be followed by a university professor, non-profit group, or school district teacher, but should be customized for each particular contact.

1. First, formulate a plan of action: what are you going to request of the company. Will it be money, a commitment of volunteer time, or both.
2. Identify a company or group of companies in the local area who you think will be willing to be your first partner. Find the point of contact in those companies who will have an interest in local community activities. Key personnel are the Community Relations Officer, corporate spokesperson, or head of human resources. Solicit the assistance of an "insider", like a colleague's spouse who works at the company, to identify the correct contact.
3. Talk with this company representative about your plans. Identify what is requested of them. Don't just settle for money! Ensure that the initial effort is a small trial that has a very high chance of success. Also ensure the initial effort will show results in a short time.
4. Once you have the company's commitment, ask to schedule a meeting ("sales" session) at the company. Provide the text to publish in the company's communication to ensure the correct audience visits.
5. Pitch the suggested involvement with employees. Try to identify two or three "champions" inside who are leaders and can sponsor your effort at the individual level. These champions will help recruit additional employees.
6. Identify hands-on activities the engineers can conduct in classrooms, especially activities familiar to the engineers. For example, at Sony Ericsson, an acoustics engineer helped create sound activities and a sound hands-on kit.
7. TRAIN the employees on how to engage kids, answer questions, and conduct the hands-on activities.
8. Have the champions serve as mentors to other employees on how to visit classrooms, including having them take the participants out to the field.

WHAT HANDS-ON ACTIVITY? A KIT?

As mentioned earlier, one does not want to send scientists and engineers into a classroom to talk about what they do without an engaging activity. Children learn by doing, so an activity that demonstrates what the professional does at work will be remembered longer that a dry lecture.

Sony Ericsson created a kit that can be carried to schools to demonstrate the engineering required to design and manufacture a mobile phone. The kit contains presentation transparencies, teacher/presenter guides, fifteen mobile phones, and tools needed to open and examine the mobile phones.

The process for these outreach activities is:

1. *Scientist in the Classroom* calls a Sony Ericsson engineer and pairs them up with a schoolteacher. The teacher could represent up to four classes in the same school!
2. The engineer contacts the teacher to arrange a date and time of the activity.
3. Shortly before the activity, the engineer checks the mobile phone kit out of the HR department.
4. On the day of the activity, the engineer packs the kit and travels to the site to perform the activity.
5. After the activity, the engineer returns the kit to storage.

This process is followed for our mobile phone kit, but could be the same for any other kit. A kit does not need to be housed at the company's site. In fact, two mobile phone kits were produced; one is kept at Sony Ericsson, and one is kept at the *Scientists in the Classroom* office. Some general guidelines to follow for making an educational kit are:

- Ensure it is complete. Provide ALL of the materials needed in the classroom, except for pencils and paper. Never assume a teacher has paperclips or tape – they may have run out for the day.
- If the kit has consumable items (i.e. paper, post-it notes, etc.), ensure there are plenty of supplies.
- Ensure the kit is provided to an organization that will commit to maintaining it and ensuring teachers have access to it. For example, the mobile phone kit described in this paper requires quite a bit of work after each session. Students tend to over-tighten the screws and strip them. We provide extra screws and phones in the kits to recover from these problems.

FIGURE. 1
A SONY ERICSSON MOBILE PHONE, AND THE PRINTED CIRCUIT BOARD INSIDE SHOWING THE MICROPROCESSOR

AN EXAMPLE OF AN EDUCATIONAL KIT

As an example of a hands-on activity kit, this section describes the kit that Sony Ericsson engineers use when they make classroom visits. The kit is a huge plastic box that contains:

- A poster of the phone already apart
- A binder with transparencies and instructional aids.
- One Teacher's Kit (larger box)
    - 4 extra pair of safety goggles
    - 2 extra torx screwdriver
    - extra screws
    - 2 extra phones
- Thirteen Student kits, each with:
    - 1 phone
    - 1 Torx screwdriver
    - 2 pairs of safety goggles

Activity steps to follow

The visit to the classroom includes several major activities: initial discussions, the hands on activity, and the debrief/wrap-up discussion.

In the initial discussion, we ask the children "what is a mobile phone?" We ask them to write their ideas on a piece of paper. We then have the students draw a picture of what they think is inside a phone. Note that these initial activities can take place before the engineer visits the classroom. The next activity is to show the poster/display with pictures of the inside of a phone. We discuss the differences they drew versus what they saw.

The hands on activity starts with the motivation for the activity, and what really is inside a mobile phone:

> *The Sony Ericsson mobile phone has a small computer chip in it, as well as other important parts. As a hands-on exercise, you will take apart a phone, examine "what is inside," and put it back together.*

The slides give the students specific instructions and hints for working on their hands-on activity. The list of instructions to the students is:

- Put on your safety glasses!
- Using a piece of paper and a pencil, write down all of the steps you used to open the phone.
- Using the tool inside, take the phone apart.
- Examine each piece. Where is the computer inside?
- Switch phones with another group.
- Following the written directions from another group, reassemble their phone (follow the instructions in reverse order).
- There are two different kinds of screws and screw-holes, colored blue and yellow. Match the colors.
- Use the lid as a container for the screws.
- Handle the parts carefully - plastic parts can break!
- If you are not sure something can be taken apart, ask!

FIGURE. 2
INSIDE A SONY ERICSSON MOBILE PHONE. NOTE THAT THE SCREWS ARE COLOR-CODED FOR EASE IN REASSEMBLY OF THE PHONE.

The wrap-up of the activity is to discuss what they observed in the phone. We describe decisions made in the design of the phone, like the selection of fasteners and placement of components inside. We also discuss the difference between a scientist, an engineer, and a manufacturing worker, and the types of engineers involved in designing and manufacturing mobile phones.

- Mechanical Engineers design the phone enclosure.
- Electrical Engineers design the circuit boards and components on the circuit boards as well as the antenna.
- Software Engineers design and write code that interfaces with the user and communicates via the radio.
- Computer Engineers design and write software to control the hardware.
- Manufacturing and Industrial Engineers design the assembly lines that make the phones.
- Systems Engineers make sure the mechanical, electrical, and computer components of a phone work together.

CONCLUSIONS AND FUTURE WORK

People learn best by doing activities. The Sony Ericsson mobile phone activity is an excellent hands-on activity to learn about technology and engineering. The ideas and materials described in this paper have been used with approximately 900 children and adults in North Carolina with very good results. This model can be applied to many companies and universities, with the eventual goal of introducing technology and engineering to all school children in the U.S.

So far the assessment of success of each session are the comments made immediately after the visit. Teachers always respond with, "the children loved it so much" and "that was great". Engineers also receive cards and letters of thanks from the students shortly after. What would be useful would be to gather more quantitative data, through surveys, of the impact of the sessions. We are currently defining the survey objectives and plan to administer a "one month later" survey starting the Fall of 2002.

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