ENGINEERING OUTREACH TO GRADE SCHOOL CHILDREN THE APPLE PIE FACTORY ASEE IL/IN SECTIONAL CONFERENCE

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Abstract*? Most children think that they do not know much about what engineers do. By using an example that they can relate to--designing a factory to make apple pies--they are able to discover most of the career areas of engineering: research and development, design, manufacturing, quality control, maintenance, and customer service/marketing. For example, children suggest using a conveyor-belt (continuous) oven rather than a traditional (batch) oven to bake the pies. This interactive exercise helps them understand engineering while having fun. It has been used successfully with approximately ten groups of students ranging from grade 3-8.*

INTRODUCTION

There are many opportunities to speak to children about engineering. These include Boy Scout and Girl Scout troops and local elementary schools. However, coming up with a talk that will be at the proper level and interesting is difficult. A brief survey of the literature found several project-based activities [1]-[2] and several longer-term activities [3]-[4] but nothing suitable for a short talk. This paper describes one exercise that has worked quite successfully.

In speaking to grade school children about engineering, it is important to actively engage them in the talk; their attention span is not long enough to last through a lecture. One good way is to lead them to discover the topics to be covered. In this "Apple Pie Factory" example, the children go beyond the easy definition of engineering, i.e. engineers figure out how to build things, to see what kinds of activities engineers actually do. Using standard engineering job functions [5], the engineering activities involved with production of a new product are discovered. The exercise is related most closely to chemical engineering, but with some explanations it can be adapted for engineering in general.

This exercise has been used successfully with about ten groups of grade school children ranging from grades 3-8 both as part of a larger engineering event and as a stand-alone visit. The group size ranged from 7 to 50, although an optimum would be approximately 25. The exercise takes about 45 minutes.

The exercise follows. The instructor's comments are shown in italics and typical student answers as bullets. Comments on the goals for the exercise are inserted between sections. In the actual exercise, a transparency or a PowerPoint presentation of the career areas is used for clarity.

THE APPLE PIE FACTORY

The talk usually begins by asking what the students know about engineering. The responses will vary depending upon the group, but there are never many details. This leads to the introduction.

"I think that you know more about engineering than you think you do. Let's imagine that we are engineers about to start work on a new project."

Research and Development: *"Let's assume that we want to build an apple pie factory. What's the first thing that we need to do?"*

- ? Some students suggest that an idea or concept is needed first.
- ? Some suggest that we look at cookbooks.
- ? The next suggestion is often to test the recipes.
- ? With prompting, they may suggest considering various types of apples.
- ? They may discuss different types of crust.

Here the goal is to show some of the basic work that needs to be done in starting from an idea. The student responses are then related to more technical concepts. For example, looking at cookbooks is consulting the literature. Testing the recipes is doing lab tests. The type of apples relates to the raw materials that will be used. In discussing types of crust, they consider various possible modifications.

The next section, design, is the most interesting. The goal is for the students to think of a variety of factors that need to be considered in manufacturing. The students always come up with the points listed below. There is a sea of hands, and sometimes it is hard to move on to the next step.

Design: *"We've made several decisions about kind of pie to make including the apples and the crust. Let's look at how engineers will design the factory to make these apple pies."*

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"Now when I make an apple pie, I get tired of peeling and slicing after one pie, and we'd like to make hundreds of pies in a day. Any suggestions?"

? The students suggest using big machines to cut the apples, mix the crust and roll it out, and mix the apples.

The children usually know that food-service machines are available. In Valparaiso, a local business, Urschel Labs, specializes in industrial food processing machinery. Some of the children are familiar with this.

"What about baking? My oven only holds four pies and an apple pie takes an hour to bake. We'd have to go all night to bake even 100 pies."

? Students suggest large pizza-style ovens.
? Others suggest conveyer-belt ovens.

Students will have seen both of these possibilities at fast-food restaurants. This leads to a description of the difference between batch and continuous operations, and a recommendation to use a continuous oven.

"What about the waste products like the peels and cores? The city will charge us a lot of money to discard them."

? Some suggest we leave the peels on.
? Someone usually suggests that we sell the waste to farmers for pig feed.

These ideas lead to a discussion of waste reduction and waste recycling. Since this is an increasingly important area of engineering, it is useful to emphasize.

"How much will the pies cost to make? What kinds of packaging will we use? These are other important things to consider in the design stage."

While the students do not have much input about these questions, it is important to discuss briefly at least the cost issue. Emphasize that the goal is to make money, so the cost to make the pie must be determined before the selling price is set.

In discussing manufacturing, the goal is to show how even a well-designed operation can run into problems that engineers will be called upon to solve. One of the fun parts of engineering is that new challenges come up every day. The students are excited to be able to solve these problems.

Manufacturing: *"Assume that we have built our pie factory using a conveyor-belt oven, and we are in production. You are the engineer and the pies are boiling over in the oven, and making the whole place stink. What do you do?"*

? Students always think of putting fewer apples in the pies.

"What if the pies are coming out too brown?"

? Students suggest turning down the temperature on the oven.
? Others suggest speeding up the conveyor belt.

Since both of these ideas would work, discuss that there are often several possible solutions to problems and engineers have to decide which will be "best".

Quality Control: *"We now have a quality product that is selling well. What happens if the quality of our pies drops? How can engineers prevent it?"*

? Students suggest taste testing some of the pies

"How many do we test? If we taste a pie, we can't sell it, and our profits go down."

? Students generally come up with a number such as 1/hour or 1/100 pies.
? Sometimes students suggest testing the filling or crust before they are made into pies.

This leads to a discussion of destructive testing and non-destructive testing.

Maintenance: *"It is important to keep the factory running. If something breaks down, we still have to pay the workers while we aren't making pies. What could engineers do?"*

? Sometimes students suggest replace worn parts before they break

In the quality control and maintenance sections, the basic goal is awareness of the issues. Students will not have thought of preventive maintenance; it may be necessary to make suggestions here.

Sales/Marketing: *"There is one last area that engineers need to be concerned with. Where do we sell the pies? How do we get them to the store? Do we advertise? What if there are complaints from the stores? For apple pies, much of this does not need to be done by an engineer, but it would if the product were more technical.*"

Usually the students are losing focus at this point, and so little or no discussion is expected. These areas are mentioned only for awareness.

To conclude, it is useful to review the career areas discussed. One way to introduce this is to ask about introducing a new product.

"What if the stores are interested in buying a pecan pie; could we make it? Where would we start?"

? A few students will remember to start with research.

"Now, do you know what we've done? We've worked through most of the career areas for engineers. While there are some differences, the same basic procedure that we

discussed is followed whether the product is apple pies, pesticides, automobiles, or cell phones. You knew more about engineering than you thought, and now you know a little more about what engineers do."

Finally, at then end of a session with middle school children, it is useful to remind them that to be an engineer they need to take four years of math when they get to high school.

CONCLUSION

This interactive exercise helps students understand engineering while having fun. It has been used successfully with approximately ten groups of students. While no formal assessment has been done, in each session the students have gotten very involved in the discussion, and there has been positive feedback from the teachers and scout leaders involved.

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