

# ROBOT DESIGN CHALLENGE

**Harry T. Roman**

Here is a fun design challenge you can use in your classroom or across the grades in your school. If you are a regional manager of a number of schools, you can challenge several schools to participate. No special tools, hardware, or supplies are needed, only imagination and teamwork. I have used this challenge with students and teachers who visited my robot application design lab; and I have applied it through The Newark Museum, with local Newark schools participating. It's always a fun exercise that illustrates technology education principles. First, I'd like to present a little introduction and discussion.

## Introduction

I often have the opportunity to talk to technology education students, teachers, and educators. Invariably, someone always asks me to identify the most important college courses I took. My answer is always a showstopper. Looking back at the audience in my very serious face, after an appropriate pause to make them believe that weighty thoughts are flashing through my mind, I boldly exclaim, "The three most important courses I took were English, laboratories, and the humanities."

After the quizzical looks are finished and the murmurs die down, I try to explain. English courses teach you how to communicate—a most fundamental skill in the work-a-day world...bedrock for all employees. Labs teach you how to work with others, the necessary give-and-take between viewpoints, egos, and differing life experiences.

But the toughest one for them to swallow is the humanities courses. Here I talk about the need to blend technology solutions with the non-technical aspects of life. New

## This design challenge is a mirror on the world.

products must be safe, environmentally neutral, socially acceptable, and in conformance with institutional guidelines and governmental regulations.

We go to college, I emphasize, not so much to study more of what we are good at, like technical subjects, but rather to discover, research, and learn more about what we don't know so well. The humanities courses put the non-technical world in perspective, establishing boundaries for us to design within.

Were our educational system more integrative, stressing multi-dimensional thinking and the interweaving of subjects, my answer probably would not appear so unexpected. But the curriculum is fragmented, highly specialized, often blurring the rich interfaces existing between subjects. It is to correct this pizza pie slice approach to education, and illustrate the multi-dimensional aspects of problem solving à la technology education that I have developed the design challenge described below.

## The Design Challenge

This challenge stems from an exercise I originally did with Grades 3-5 at my robot design and application lab in central New Jersey. I would invite local schools to bring teachers and students into the lab twice a month to have teams of students see and actually operate mobile robotic devices I was developing—and then have these students try to design a personal robot to assist a physically challenged person. It was a most

popular activity with both students and teachers. It took about 2-3 hours to hold the design challenge, and winners received a robot t-shirt. All told, I estimate about 1000 students and teachers took the challenge. And yes, the students always blew the teachers away with their designs. It wasn't even close in most cases.

When my robot design lab completed its mission and was closed, I still wanted to use the design challenge with students. I no longer had real robots for them to see, touch, and operate, but I felt the challenge could still be used with excellent results. Here is an interesting way we kept this great activity going.

Working with the in-service educational instructors of the nationally recognized Newark Museum in Newark, New Jersey and local Newark School teachers, we redesigned the program to be a more intense two-week activity. The winning teams from a number of schools and classes involved (mostly the 3rd through 6th grades) displayed posters of their designs at the Museum, where judges assembled to select the best ones, and awarded savings bonds as prizes.

Here is how the two-week design challenge was structured. You will see how it related to the three important courses that I mentioned earlier had influenced me the most in college.

## Initiating the Design Challenge

Students are arranged into five-member design teams. Each team is to imagine itself in the business of designing robots for sale to the public. The teams may select their

own company name, as well as the name of their robot product. The challenge is for each team to design a mobile robot that can assist a physically challenged person, or perhaps someone confined to a wheelchair.

There are five basic design constraints for the teams. This robot should be able to:

1. Pick up small objects like coins, keys, a wallet, etc.
2. Reach behind furniture and retrieve objects.
3. Operate for a full day without needing recharging.
4. Withstand continuous day-to-day use; be rugged, yet lightweight.
5. Be easily affordable—not expensive.

### How It Happens

The students are allowed to freely meet and think about their designs, and are encouraged to develop their own way of meeting the five basic design constraints listed above. There is no right or wrong answer, only the answer they feel best expresses their achieving the design constraints. They must agree on what they wish to do and what course of action they will take.

With a five-member team, each student must play a specific role on the team and represent that viewpoint.

- Team leader and captain of the team: Integrates the various concerns and suggestions of the other role players.
- Design engineer: In charge of the technical aspects of the design and the materials to be used.
- Customer representative: Looks out for the interests of the user of the robot (the handicapped person).
- Human interface designer: Whose job it is to make sure the robot is user friendly to the customer.
- Economist: Develops a cost estimate for the robot that will make it affordable to the customer.

### What is Expected of the Students

Each team has two weeks to complete its design and must produce the following:

- A written report on its design.
- An estimate of the cost of the robot.
- One or more posters that illustrate the robot and how it functions.
- A list and description of special features built into the robot.
- An oral report in front of classmates describing the robot and answering questions.

### The Importance of the Challenge

This exercise is designed to foster teamwork and reinforce communication skills, teach making tradeoffs between the roles they assume, and integrate their various roles and viewpoints together into a final design. Since there is no right or wrong answer, the students must reach consensus as to what they are trying to do, how best to do it, and organize their collective resources to accomplish the consensus position.

This design challenge is a mirror on the world, very similar to how projects are managed and led in industry. The team leader of this exercise should have good leadership skills, be articulate, and able to provide direction and counseling to the team to encourage them to reach their goals if they get stuck.

The students should realize the importance of writing and speaking well. Good ideas poorly presented in the workplace are not likely to be listened to seriously, and in all likelihood will not be implemented. Good communication skills are enormously important in the world of work and essential to selling products to the public—whether they are robots or anything else. That is why communication is built into this design challenge.

Teachers, you should precede this challenge with some robot classroom research, including visits to the rich robot Web sites that now exist, and



perhaps a few hours of class time spent discussing how robots operate and are being applied in the world today. Perhaps you can locate a robot company or a robot engineer to visit with the school(s) to help introduce robotic concepts to the students. This would be ideal.

It also would be very helpful in this exercise if time were spent in the classroom beforehand discussing creativity techniques and how teams are much more creative than individuals. The students should be encouraged to think “outside of the box,” with an emphasis on meeting the design constraints.

Show the students how to brainstorm and capture their ideas on paper before trying to rush into a design. The process of planning the project is as important as executing the solution, for once the basic concept of planning a project is understood, it can be repeated for many different types of projects. It is a repeatable process highly sought after by companies. People who can work in teams and know how to carry out projects are in great demand.

I hope you enjoy this design challenge as much as I do.

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