Kids Inventing Robots

Ed Sobey, Ph.D.

THE ROBOTS DANCED, SPUN, TWISTED AND WHIRLED IN A BALLET OF TECHNOLOGICAL PROWESS. THE ROBOT INVENTORS HAD DESIGNED, BUILT AND PROGRAMMED THE SMALL MOBILE MACHINES TO SHOW OFF WHAT THEY HAD LEARNED IN A ONE-WEEK INTENSE CAMP CALLED KIDS INVENT ROBOTS.

Ed Sobey, PhD, is president of the Northwest Invention Center and vice president of Kids Invent Toys. Ed has directed five museums and published a dozen books. Contact him at *ed@kidsinvent.org*.

Like many kids, most of these inventors didn't have much experience with electric circuits let alone robots when they started the camp on Monday. They developed skills using tools, discovered how to work with new teammates, and learned how to think like inventors. They solved problems, programmed in two languages, and learned much of the physical science content specified by national standards for intermediate and middle school grades. And, they had fun.

The purpose of Kids Invent Robots and all the Kids Invent Toys programs (www.kidsinvent.org) is to empower kids to undertake creative projects of their own design. The robotics camp caters to kids who have finished at least 5th grade.

Rather than using snap-together toy components that require users to purchase everything from one vendor, we chose to have kids make robots from the most basic components possible. Thus aligning the wheels and motors is not trivial. Connecting components isn't automatic. This strategy makes preparation more time-consuming, but it also allows kids to purchase or scrounge parts from anywhere they can. It also lets them to add new components from a wide variety of vendors as their interests and resources allow.

The pedagogic premise of all Kids Invent Toys programs is that kids will learn when challenged to design, build, test, and document fun projects that tax their skills and allow them freedom to follow their creative ideas. In other words, the programs create learning situations in which students become problem-solving inventors.

To ground the students with some basic understanding of electric circuits and mobile platforms, their first team challenge was to design, build, test, and demonstrate a model car that could propel itself 20 feet. We provided wheels, dowels, straws, a variety of potential car bodies, batteries, DC motors, propellers, and clip leads. They could also use materials they had extracted from VCRs and other appliances during a take-apart activity.

Surprisingly, teams had difficulty cutting car bodies out of the wood provided. Obviously, many had not used or hadn't developed skill with wood saws. With much peer-to-peer teaching occurring, teams created car models that rolled in straight lines and then added propeller drives. When all teams were ready, they raced their cars. The group then examined each model to discover its design strengths and weaknesses.

In Kids Invent Robots, there's one challenge after another with a minimum of formal instruction. Next the kids raced their cars backwards and forwards between two goal lines. Then teams converted their prop cars into belt-driven and direct-drive models. We then added remote cable control. By the end of the first day they had learned how to use a variety of hand tools, how electric circuits and motors work, and how their teams work.

Day two has each team build an inexpensive model robot from a kit. Each team works together to build one robot. After they have it working they help each other build robots so each team member has one to take home to show family and friends what they are working on. Building the kit robot exposes them to the power of digital circuits and prepares them for designing their own robot.

The next jump in challenges occurs as they see a demonstration of how an autonomous robot works. Each robot is constructed from plywood, wheels, servos, and a Stamp-II integrated circuit mounted on a Parallax breadboard.

After the demonstration robot-building teams create designs for their platforms and, after they get approval from the management team (volunteers and the leader or robot factory President) they cut it out of plywood. They mount the servos, affix wheels, and install the control systems. Once the hardware is complete, they take their robot to a computer and copy a few lines of code that they download to their robots.

Teams refine their programming skills and their understanding of servomotors by solving several problems. First they make their robot travel in a straight line. The next challenge is to have it follow the outlines of a square taped to the floor and return to the starting position. They build their skills in programming by meeting other challenges throughout the day.

In other problem-solving challenges and games, kids learn to think like inventors, to try new ideas, to learn from mistakes, and to pick up ideas everywhere they can. They practice brainstorming to come up with ideas for a robot invention. As they are working on these plans they move to the computer lab to learn how to create web pages.

Web page construction is an important element of Kids Invent Toys programs. It is the culminating experience in which teams showcase what they've invented. We post their web page on the Kids Invent Toy's server so they can show family and friends what they've done. They learn the basics of HTML programming and start making their page in a couple of hours in the lab.

Showing off their robots.

Teams continue to work on their robots, getting them ready for a public showing on the last day. Some teams create a new base, others focus on adding sensors or lights, and some focus on programming movements of their machines.

The next new challenge is problem solving of a different nature. Each team is responsible for developing a business plan to start their own toy robot company. With the help of the management team, they think through the price and cost structure of their invention and consider how they would manufacture and market it.

Kids Invent Toys uses skits and role playing demonstrations to convey content related to crea-

Testing model cars in head-to-head competition.

This team attached markers to their robots and programmed them to create works of art.

Attaching a caster to the robot platform.

Wiring the breadboard.

tive thinking methods, business plans and intellectual property rights. The skits are hokey and unpolished, but usually culminate with enthusiastic applause.

By Friday afternoon each team has built and demonstrated a robot of their own design. They also have constructed a web page including a photo of their robot and they have built a variety of self-propelled model cars or boats. When they leave they take with them a resource list of stores and web-sites they can access to get more information and to purchase components for future robot projects. They have thought through what type of services their robots could provide, like those described in "Service Robots" (*Ties*, October 2000) and have mapped out a business plan. They also know about robotic contests they can enter, like the Trinity Fire-Fighting contest, BEST, and US First.

Kids Invent Robots integrates the excitement of robots with the creative problem-solving pedagogy of Kids Invent Toys program to create an unparalleled week of hands-on learning. Amidst the creative fun they learn about forces and motion, electric circuits, computer programming, energy storage and transfer, and other topics specified by national and state science standards.

This summer museums, schools, and universities in several states will be using Kids Invent Robots. For an up-to-date list, visit the Kids Invent Toys website (www.kidsinvent.org). Educators interested in hosting a robotics program can contact the author (ed@kidsinvent.org).

Experimenting with uses for robots.

Cutting out a robot platform.

One team took apart a toy car and used the body in their robot.

The **Kids Invent Toys** website has been revamped to guide kids through the inventing process. In an interactive format it helps kids formulate ideas for inventions and then helps them design their inventions. It gives practical advice for building and testing inventions and for what kids can do with inventions. The site is ideal for kids entering an invention contest and for those who always wanted to be inventors but didn't know how. Check it out at ***www.kidsinvent.org.***

Botball

Each spring thousands of middle and high school students build and program robots to compete in regional Botball competitions. Botball is the flagship program of the KISS Institute for Practical Robotics, a nonprofit organization based on the philosophy: "keep it simple stupid." In 2001, tournaments were held in Oklahoma, Texas, Florida, Pennsylvania, California, and Washington, DC. Regional winners went on to compete in the annual national tournament.

Botball is an exciting way to have fun and develop problem-solving skills and to integrate science, math, technology, and engineering. To get their school involved, teachers attend a professional development workshop where they spend three days learning about robotics. At the conclusion of the workshop they receive a special kit that includes everything their students need to design, build, and program a mobile robot. After the tournament, schools get to keep the equipment for classroom use.

Students work in teams and have about six weeks to create their robot and then compete in regional tournaments. The robots are autonomous and are programmed in the C language. The game is played on a 4' x 8' board where robots are awarded points for placing white or black balls in scoring position. In addition, students create their own website in response to a specified challenge. To maintain the challenge, the materials included in the kit, the specific objective of the game, as well as the website design problem are modified each year.

From start to finish the experience provides valuable workplace skills including teamwork, problem-solving, and recognition that failure can provide a great learning opportunity. The cost per team is $2,000. Many teams find corporate sponsors to help cover the cost and link with mentors to provide technical assistance. Financial aid may also be available. For more information about the KISS Institute and the Botball program visit www.botball.org.