

## The Little Robot Tournament That Could

Cathryne Stein, Darcy Hartz Schein  
KISS Institute for Practical Robotics  
cstein@kipr.org / dschein@kipr.org  
(405) 579-4609

### Abstract

The Botball Educational Robotics Program for middle and high school students is designed to leverage the excitement students feel about robotics and use this to improve skills and understanding of science, programming, and engineering for several different kinds of learners. Botball features autonomous student-created robots in regional tournaments, and caps each season off with a national tournament. This year we grew the national tournament into a full conference designed specifically for students, teachers, families, mentors and professional researchers and engineers interested in contributing to this educational process. Despite obstacles and a learning curve, the results were valuable.

### Introduction

When you take an educational robotics program that culminates in a national robotics tournament, and you announce that this tournament is now going to be the centerpiece of a new educational robotics *conference* for middle and high school students and teachers, you are going to hear some muttering. People don't like the thought of change, generally speaking.

When teachers ask if students can just sign up for the tournament alone, and you tell them no, registrations are for the entire conference, which features speakers from NASA, project management specialists, AI engineers, and both student and teacher tracks, and would they and their students care to submit a paper or give a demonstration? . . . people will stare at you in disbelief (and you will discover that many teachers have never attended an academic or professional conference.)

But when the last 9<sup>th</sup> grade student has given her demo, the teachers' best practices workshops are over, technical innovation has been presented by 6<sup>th</sup> through 12<sup>th</sup> graders along with supporting math, and the tournament trophies have all been awarded, then you realize that people have clearly changed their attitudes. In fact, they're already talking about what they're planning to show for next year.

KISS Institute for Practical Robotics launched the Botball National Educational Robotics Conference last year, specifically geared to middle and high school students, teachers who use autonomous robotics in the classroom, and the families who love them. The results were more satisfying than anyone could have predicted.

### Background: Botball Educational Robotics Program

The field of robotics is well suited to education. It is multidisciplinary, combining science, math,

engineering, design, language arts, and even ethics. Educational robotics is usually multi-modal, involving programming, mechanical design and construction, teamwork and project management. This can be a real opportunity for students with learning styles not typically suited to classroom work to flourish and demonstrate their talent.

The Botball Program is the main educational initiative at the KISS Institute for Practical Robotics. Botball is an educational program for middle and high school students that starts with a professional development workshop for teachers, and uses the activities of robot programming, design, and construction as well as website development to get kids engaged in being on the creative side of technology. Botball is loosely derived from the original MIT robotics competitions.

In Botball, middle and high school student teams have about six weeks to design and build small, autonomous mobile robots to play a specified game, which changes annually. Students must also document their processes, including their strategy, software, design and project management procedures, and include this information on a website of their own design, hosted by KISS Institute.

At the end of the six weeks a regional public tournament is held and trophies are awarded for robots, special features, documentation and websites. Botball is distinctive in that these robots are programmed in the C language, no remote control is used, and that Botball robots are designed, built and programmed by students only (in fact, adults are roped off from the pit area at tournaments).

According to survey data gathered after participation in the national Botball program and compiled by the Statistical Consulting Center at Virginia Tech<sup>1</sup>, of eighty-nine randomly selected Botball students:

- 85% reported greater appreciation of the usefulness of math and science, and 60% reported that their attitudes became more positive about these subjects compared to how they felt before Botball;
- 35% felt that Botball influenced their career choice, and 37% felt Botball influenced their desired program of study when they went to college;
- 86% wanted to participate in a college level Botball program.

Botball is national in scope and takes place in regional programs across the country. The program culminates in an open National Botball Tournament.

### **Motivation and purpose of growing a tournament into a conference**

In previous years, our National Botball Tournament was hosted by the American Association for Artificial Intelligence (AAAI) at its annual professional conference. AAAI also donated travel grants to students. Students benefited from seeing what professional scientists and researchers were doing in the field, and there was great value in the interaction between the role models and Botball students.

Since September 11, 2001 it has become harder for school groups to travel, and some have been forbidden from crossing international borders. When AAAI announced that their 2002 conference

would take place in Edmonton, Alberta, we realized we had to cancel our tournament or come up with a new plan.

We used this as an opportunity to envision our dream conference for the population we worked with: middle and high school students, their teachers, families and mentors, as well as engineering professors and engineers interested and involved in educational outreach.

We realized that much of our younger population had no experience attending conferences designed specifically for them, so this would be an introduction to the joy of intellectual exchange, networking, and the opportunity for discussion of related topics and larger issues and ideas beyond the competition. Our purpose was to use the fun and inspiration of this event to take their interest to a higher level and steer even more students of diverse backgrounds toward a career in a technical field.

### **National Conference on Educational Robotics**

The conference took place in Norman, Oklahoma June 29-July 2, and the National Botball Tournament was billed as a main event. It offered pre-conference workshops, invited speakers, poster sessions, exhibits, and breakout sessions featuring juried papers written by middle and high school teachers, students and mentors.

#### *Attendance*

National Conference participation included 52 teams from across the country, roughly 25% of the teams who played in regional tournaments. A total of 382 individuals registered for the conference (including teams), of which 225, or 58% were students. The rest were teachers or mentors (62), chaperones (38), and guests/others (57).

#### *Invited speakers*

Plenary speakers from NASA, Naval Research Laboratory and University of Oklahoma were invited to give students interaction with professionals in robotics. Speakers discussed robotic exploration, project management, artificial intelligence and learning, and then tied those topics to the concepts the students were learning in Botball. Our goal was for students to envision themselves in careers and higher education in STEM areas by hearing about each presenter's areas of research, personal stories, and experiences in the field.

#### *Break-out sessions*

While the plenary sessions gave participants the opportunity to hear about cutting edge developments in robotics, the break-out sessions allowed participants to share their own discoveries about using robots in science, technology, engineering and math.

Students presented their ideas on everything from new building strategies to sophisticated mathematics in robotics. They gave a variety of papers including:

- Barry Kline's Quick Release Battery System
- On the Application of Artificial Intelligence Theories: Improving Robotic Navigation, Cognizance, and Adaptivity
- Summation Architecture and Pipe Mazes
- Robotics – An application to real-life situations

Papers were presented by both middle and high school aged students. Not only were the student presenters outstanding, but attendance from other students was high indicating that students like to learn from other students. We were pleasantly surprised by the degree of technical knowledge in the papers along with the clear application of science and math subjects they learned in school and in Botball.

The teacher track provided a forum for teachers to exchange curriculum ideas and best practices. Sessions included Using Robotics with "Labeled" Students, Teaching Content with Robot Kits, Mentoring, and a workshop on Project Management. In addition to the sessions, a Teachers Lounge was provided which offered an abundance of resource materials to look through and a place to network with other teachers. The networking that took place in the Lounge and in the sessions was an important benefit of the conference, and feedback forms indicated that it gave renewed inspiration and ideas to many teachers.

### Showcase

One of the most popular activities at the conference was the Robot Showcase. It was a combination of a Poster Session and Robot Exhibition. Some students set up displays reflecting their paper's content, while others demonstrated what they had created outside of the Botball competition. The discussion between students, teachers and parents created a lively atmosphere where innovations and suggestions were exchanged. College students were included in the showcase as well, demonstrating the next step in pursuing a career in STEM areas for the middle and high school crowd.

### Robot Film Festival

Unlike most conferences, this event also featured a Robot Film Festival followed by a discussion on a controversial topic designed to appeal to the students (this year's topic: should robots have rights?) but provoking just as much response from the adults. A research scientist from the Navy Center for Applied Research in Artificial Intelligence moderated the discussion.

## **Survey Results regarding the Conference**

Survey results indicate that the added conference element was perceived as a definite benefit. When asked if they preferred a national event that was tournament only or tournament plus conference, 82.4% indicated that they preferred the tournament and conference combination. Of the 17.6% who preferred a tournament only, 84.6% were students.

Typical written feedback included comments such as:

"I liked the breakout sessions because you got to learn stuff and maybe get to do something as cool as the talkers." – *DC Student*

"The conference part makes the event so much more educational, especially to school administration." – *Southern California Teacher*

" 1) great facility; 2) healthy food; 3) excellent spectrum of talks; 4) good networking chances; 5) great technical set up. Everything was smooth." – *Indiana college professor (and HS parent)*

We had some areas to work on for the following year as well. Teams indicated that they wanted more practice time in addition to sessions. We also changed the conference name to the National

Conference on Educational Robotics to be more inclusive, but still reflect the broad scope of using robotics in the service of education.

### **Collegiate Botball – Reinforcing the pipeline to undergraduate engineering**

To further cement the pipeline from middle and high school engineering programs to higher education, this year we're developing Collegiate Botball. Many Botball students graduated from high school, but asked to continue to participate in Botball. These requests indicate that students will still actively pursue a higher-level continuation of **familiar** hands-on engineering activities after high school, and that a familiar project-centered approach may be helpful in recruiting and retaining undergraduates in the field of engineering.

This will be the first year of Collegiate Botball, and we will co-locate the tournament with our National Conference on Educational Robotics, giving middle and high school students the opportunity to see college students in action. Collegiate Botball will use a somewhat different and more challenging game, but a similar kit. Collegiate Botball is open to anyone enrolled in any level college or university class as of Spring 2003. Registrations are available at our website [www.botball.org](http://www.botball.org).

### **How to Participate**

There are several ways to use Botball to support a variety of activities and interests. If you are affiliated with a university, you can challenge your students to field a Collegiate Botball team this year. They can register at our website [www.botball.org](http://www.botball.org).

Universities can also use Botball as outreach to local schools and to help recruit talented high school students (we have seen recruiting going on right there on the tournament floor after particularly brilliant programming or mechanical designs were displayed). Interested parties can email us about being involved in an existing regional tournament or starting one in your area.

Middle or high school educators can register teams at our website. Financial aid is usually available as needed, and there are twelve regional tournaments across the country.

Everybody is welcome to attend this National Conference on Educational Robotics, which will take place in Norman, Oklahoma June 28-July 1, 2003, and (tentatively) in San Jose, California in early August 2004. Information is available at [www.botball.org](http://www.botball.org).

Like ASEE, Botball promotes higher education and careers in technical fields. We want to extend an invitation to ASEE as an organization, and ask if there are individuals or committees that are interested in becoming involved with this program, or sponsoring and mentoring teams. Please contact us for more information about local teams or tournaments.

### **Parting thoughts**

Botball is much more than a competition. What started out as an autonomous robot tournament for kids has grown into a learning experience that not only provides students and teachers with the opportunity to learn robotics, but also presents an opportunity for participants to learn from one another. The National Conference on Educational Robotics has become a forum where teachers, students, parents, professionals and mentors can exchange ideas, providing a much richer experience than a competition alone.

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<sup>1</sup> Statistical Consulting Center, Virginia Tech, 2003. Results from the National Student Survey. Unpublished report.