Generating Interest in ET through High School Competitions

Prof. Alka R Harriger, Purdue University, West Lafayette

Alka Harriger joined the faculty of the Computer and Information Technology Department (CIT) in 1982 and is currently a Professor of CIT. For the majority of that time, she has been actively involved in teaching software development courses. From 2008-2014, she led the NSF-ITEST funded SPIRIT (Surprising Possibilities Imagined and Realized through Information Technology) project. Since October 2013, she has been co-leading with Prof. Brad Harriger the NSF-ITEST funded TECHFIT (Teaching Engineering Concepts to Harness Future Innovators and Technologists) project. Professor Harriger's current interests include application development, outreach to K-12 to interest more students to pursue computing careers, applying IT skills to innovating fitness tools, and wearable computing.

Prof. Bradley C. Harriger, Purdue University, West Lafayette

Brad Harriger has over 30 years of experience teaching automated manufacturing and has authored/co-authored several related articles. Professor Harriger has served in several leadership roles with Society of Manufacturing Engineers and the American Society for Engineering Education, and is a founding member of an international Aerospace Automation Consortium, serving on its steering committee for several years. He has invested over twenty-five years in the development and maintenance of a multimillion dollar manufacturing laboratory facility complete with a full scale, fully integrated manufacturing system. Professor Harriger has been a Co-PI on two NSF funded grants focused on aerospace manufacturing education and is currently a Co-PI on the NSF funded TECHFIT project, a middle school afterschool program that teaches students how to use programmable controllers and other technologies to design exercise games. Additionally, he co-organizes multiple regional automation competitions for an international controls company.

Generating Interest in ET through High School Competitions

Abstract:

Finding ways to generate interest in Engineering Technology (ET) is an ongoing challenge for many colleges and universities. Starting early is always recommended; however, employing recruitment initiatives even in high school may yield success when the right motivators are used. Having strong corporate partnerships not only enables delivery of specialized programs but also strengthens the message from both an academic and industry perspective.

The authors partnered with an international manufacturing company that offered a national competition to high school students as part of their STEM outreach. Although the event was labeled as being national, the vast majority of teams were located near the company's headquarters. The recruitment begins in October and the final contest is in mid-February. There are several checkpoints along the way which determine whether a team has accomplished enough to stay in the contest. This paper describes one high school competition that began as a "national competition" at a single location in 2009 and has evolved over the past three years to a competition that now includes three regional contests where national qualifiers are selected to compete nationally.

Introduction

In 2010 the authors approached Phoenix Contact[1], an international controls company, to become a technology supplier for a grant that they were submitting to NSF. Two years later, when the authors met with their corporate partner, they were asked to become an educational partner with their company and assist them with a high school controls competition that they had started several years earlier. Although the company called their contest a national competition, they acknowledged that it was more of a regional competition at best, given that nearly all of the teams were located near their corporate headquarters.

The Competition

The Nanoline Contest is a high school technology competition that allows student teams to showcase their technical skills in designing and implementing an automation project. While the contest targets high school teams, a few middle school teams have participated over the years. Each team may have no more than six students, each of whom are 18 years or younger. An adult mentor, usually a teacher or business professional, guides the team and serves as the main contact with the sponsoring company.

To apply, each team provides a viable project idea and list of participating team members. Once accepted, the team is provided a starter toolkit. The contents of the toolkit are listed in the next section.

There are three checkpoints for which materials depicting the team's progress are submitted to the sponsoring company. Failure to submit materials by the deadline or failure to meet the progress expectations of the sponsoring company will cause a team to be removed from the

remainder of the competition. The schedule for the 2015 competition is available on the corporate website and shared in Table 1.

Table 1: 2015 Nanoline Competition Schedule[1]

Date	Description
September 17, 2014 October 24, 2014	Nanoline Contest Launch Closing Date for Registration
November 14, 2014	Checkpoint 1: Educator and mentor updates
December 13, 2014	Checkpoint 2: First round selection (Response by December 16)
January 23, 2015	Checkpoint 3: PowerPoint / YouTube submittal
February 7, 2015	Regional Contests (Selection of National Qualifiers) Northeast, Midwest
February 14, 2015	Regional Contests (Selection of National Qualifiers) Southeast
February 21, 2015	Final Judging & Interview of Teams in Harrisburg (Afternoon) Winner Announcement
February 22 to February 28, 2015	Engineers Week in Harrisburg. Projects are on display at Phoenix Contact, Harrisburg
April 16-19, 2015	2015 VEX Robotics World Championship, Louisville, Kentucky

The project requirements are relatively wide open, allowing the students to create anything, with the following expectations:

1. It should be in good taste.
2. It must use a supplied Nanoline controller with its supporting NanoNavigator software.
3. The project must fit in an area of 1 meter by 2 meters. Additionally, it should be no higher than 1.2 meters if on a table or 1.9 meters if on the floor.

By the final checkpoint, the projects must be somewhat operational to be invited to their regional competition.

At the national competition, one winning team is selected. Until 2015, the winning team received an all-inclusive, paid trip to the Hanover Fair Automation Show in Hanover Germany. This international trade show is the largest European trade show geared towards manufacturing and automation.

The Competition Toolkit

The toolkit supplied for the competition is provided free of charge to each registered team that submits a viable project idea. The contents of the toolkit are shown in Table 2.

Table 2: Nanoline Toolkit

Quantity	Description
1	Nanoline Programmable Controller (8 digital inputs, 4 digital relay outputs, 2 analog inputs and 2 analog outputs).
1	24 Volt Power Supply
2	I/O Expansion Modules (3 digital inputs and 4 digital relay outputs)
2	2 amp circuit breakers
10	Terminal Wiring Blocks
2	Screw drivers
1	Ferrule crimper with 2 small bags of ferrules.
1	Copy of Nanonavigator software (Free Web download)
1	$200 gift card for help in purchasing project items.

The materials in the toolkit are valued at around $500.00. Additionally, they receive a $200 gift card to purchase related materials for their planned project, such as lumber, electronic components that are not part of the toolkit, and marketing materials. Teams are also encouraged to conduct fund raising activities to garner support from local industry and businesses.

Judging Criteria

The sponsor identifies several categories for judging the projects at the competitions. Some are evaluated on a pass/fail basis, while others are assigned a weight and may receive points up to the maximum weight allotted.

The most important criterion is the team's utilization of the controller itself. In past competitions, teams created very useful and attractive projects that performed well; however, they designed the project to be powered primarily by an alternate controller and used the Nanoline in a secondary or tertiary manner.

Another important criterion is the functionality of the project. Although teams may only qualify to compete if they pass the final checkpoint, there are several weeks that remain before the competition. During that time, the team could introduce problems and cause a working project to fail. Alternatively, the sponsors may have had more confidence in the team's ability to finish the project by the date of the contest, but the team's project ended up being non-functional by the date of the contest.

Other criteria used in judging include the project concept, engineering/design, craftsmanship, teamwork, marketing, and entrepreneurial spirit.

Moving from "National" to National

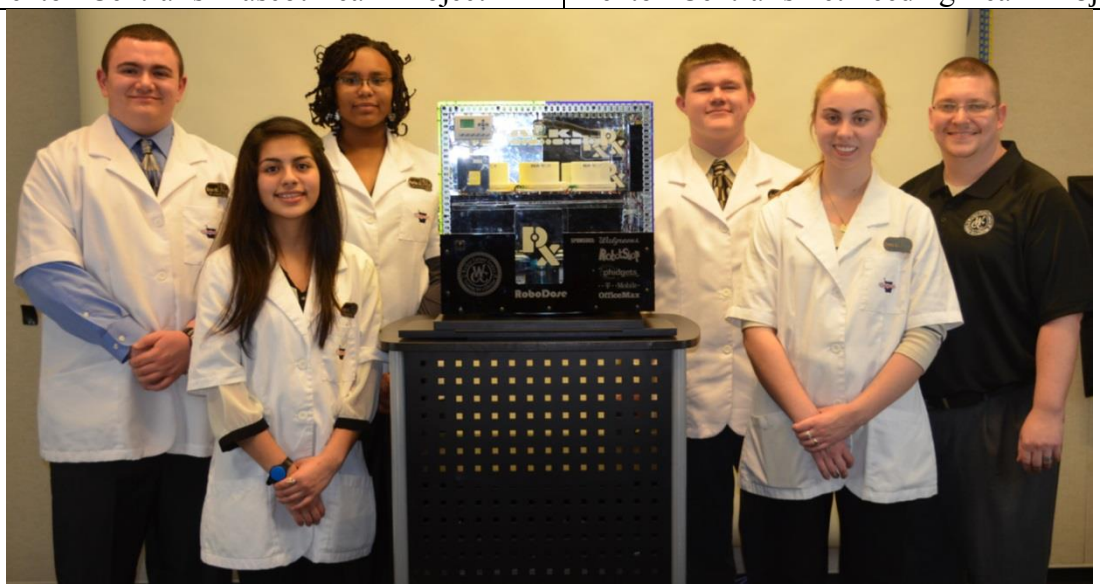
In 2012, the company invited the authors to help them make the competition more structured and selective by adding a Midwest regional competition that would send their best teams to the national contest. Although the timetable for the national contest was already well underway, the sponsor would have been satisfied if one to two teams could be found from the Midwest

regional. Further, if at least four teams could be recruited, they would support an actual regional contest for that competition cycle. Within a week, the authors were able to recruit thirteen teams, so a regional competition was instituted. One or more teams dropped out at each of the checkpoints along the way, but by the time of the regional tournament, four teams still remained. The top two regional teams were selected to compete in the national contest, and both placed in the top five among a pool of nearly twenty teams.

In 2013, the industry partner created their own location as a Northeast regional site. This allowed for up to the top three teams from each of the two regionals to compete in the national contest in February 2014. The Midwest regional began with a pool of 18 teams of which 9 satisfied requirements at all checkpoints to compete in the nationals. Three teams from each regional were selected to compete at the national contest. Figure 1 shows the Midwest national qualifying teams that competed nationally, including the winning national team.

Benton Central's Mascot Team Project

Benton Central's Pet Feeding Team Project



Walker Career Center's 2014 Team with RoboDose Project: 2014 National Winners

Figure 1: Midwest Region's Three 2014 National Qualifiers

Based on the successes of the 2013-14 regional framework, the industry partner added a third regional for the 2014-15 timetable. The third regional included the Southeastern part of the country, and was also managed by the authors. The Midwest regional began with 18 teams, and

the newly instituted Southeast regional recruited 9 teams. Unlike previous competitions, however, very few teams passed the final checkpoint. Only two teams from each of these regionals demonstrated sufficient progress to convince Phoenix Contact that they would have functional and competitive projects by the time of the national contest. The sponsor cancelled the Midwest and Southeast regionals and invited those four teams (shown in Figure 2), along with four teams from the Northeast regional to compete at the national contest. The winning team was again from the Midwest regional: Benton Central's t-shirt cannon project was a unanimous choice of the judges.

Benton Central's T-Shirt Cannon Project

Walker Career Center's Bellhop Project

East College East's SCARAB Robot Project

East College East's Vending Machine Project

Figure 2: Midwest and Southeast Regions' 2015 National Qualifiers

Future Plans

Immediately after the national contest, the authors met with several Phoenix Contact staff who were involved with the contest. The goal was to identify ways to have enough teams qualify to compete at the regional contests. Some of the suggestions included the following:

1. Conduct a survey to determine the characteristics of mentors of successful teams. Then, particularly for the inexperienced teams, ensure that they have suitable support and/or mentors based on the results of the survey.
2. Modify the schedule to begin the competition earlier.
3. Strongly encourage teams to attend the jump-start workshop.
4. Enhance communication, including clarity on the roles of the various people involved with the contest at each level.
5. Consider developing more video tutorials on various aspects of using toolkit components.

6. Create and share rubrics for deliverables at each checkpoint.
7. Provide examples of viable projects.
8. Select prizes that would motivate students and teams to seek help when they get stuck rather than dropping out.

Based upon the success of past contests and the impact in engaging student interest in pursuing STEM subjects, the authors and Phoenix Contact staff plan to continue the contest for the foreseeable future.

Conclusion

Competing student teams employed their creativity and technical knowledge to innovate products that addressed the specifications defined by the company. In the process, the students learned more about opportunities to pursue ET fields of study that would enable them to have careers related to the fun experience of the competition. The authors believe this type of competition is a good way to forge strong relationships with a corporate partner while simultaneously sparking student interest in ET. More details about the contest, including updates regarding the status of the current competition, will be shared during the presentation.

References

[1] Phoenix Contact USA. (n.d.). *Nanoline Contest 2015*. Retrieved February 2, 2015, from https://www.phoenixcontact.com/online/portal/us?1dmy&urile=wcm:path:/usen/web/corporate/company/subcategory_pages/nanoline_contest/58c0983c-607d-4eb7-9c38-70fad97e8348/58c0983c-607d-4eb7-9c38-70fad97e8348