AC 2010-615: ROBOTICS INNOVATIONS COMPETITION AND CONFERENCE (RICC): BUILDING COMMUNITY BETWEEN ACADEMIA AND INDUSTRY THROUGH A UNIVERSITY-LEVEL STUDENT COMPETITION

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Robotics Innovations Competition and Conference (RICC): Building Community between Academia and Industry through a University-Level Student Competition

Abstract

While robotics competitions exist at the K–12 and university levels, these are notably based on games with a fixed set of rules. We believe that existing competitive games do not suffice, and what is needed is a competition that emphasizes the engineering of solutions to open-ended real-world problems inviting creativity and innovation. Therefore, we developed a Robotics Innovations Competition and Conference (RICC) to build an intercollegiate and multi-disciplinary community of students, faculty, and industry promoting the education of entrepreneurially-oriented robotics engineering students. The first regional competition and conference was held at Worcester Polytechnic Institute November 7-8, 2009.

The competition challenged students to design and build robots to perform useful and novel tasks through a university-level competition, with the theme of "improving the quality of life" chosen for the 2009 event. Entrants were judged primarily on the extent to which they innovated and met existing needs or created new markets with regard to the theme, and secondarily with respect to design and analysis, implementation skill, and business plans.

RICC accomplishments included: a) an RICC website which had over 139500 accesses, b) a social networking site which added a significant number of competing team member participants, c) 14 university teams registered to compete from as far away as Egypt and Mexico, highlighting the international aspect of the community building effort, d) Steering Committee formation involving robotics industry members and university faculty, e) several student projects on social aspects of the RICC, f) setting the format and schedule for the conference, g) refining the competition format and scoring rubric, h) holding the First Annual 2009 RICC, i) conducting a survey of RICC attendees and assessing the results.

We report on the extent to which the competition and conference achieved four major goals: (1) stimulating students to imagine new robotics applications and encourage them to develop their ideas into working prototypes; (2) bringing student work to the attention of industry leaders who may see opportunities to further develop the students' ideas and providing a forum where the students can meet with industry representatives to learn about needs and new problems; (3) generating increased support for science and engineering nationwide by raising awareness of the roles of science and engineering in technical progress; (4) creating a new forum for educators from many institutions to share their successful ideas for curricular and project content related to innovative robotics applications, thus speeding the growth of this new and important field.

1. Introduction

Robotics—the combination of sensing, computation and actuation in the real world—has long captured the interest of the American public. Today, the field is on the verge of rapid growth, as the androids of yesterday's science fiction give way to practical, useful, and affordable devices in defense and security, consumer products, transportation, and medicine. Yet, successful

applications of off-the-shelf robotics seem surprisingly meager. With a few notable exceptions robots are not everywhere. This dearth has been due, in large part, to the lack of physically and computationally capable component systems. This is about to change. We have probably reached the point where in many cases the biggest challenge is not building a robotics device but to imagine new things that robots can do. This is not meant to imply that technical challenges do not exist, but rather that our ability to solve technical challenges has outpaced our ability to imagine what new tasks robots can do for us. Thus—as emphasized by Bill Gates[1]—we are in many ways at a point where the personal computer industry was in the mid and late seventies when the hardware had reached the performance/cost threshold needed for industry to take off.

Just as the "PC Revolution" and the "Internet Revolution" attracted students to computing and related engineering fields, leading to the creation of new enterprises, industries, and economic vitality, the "Robotics Revolution" has the potential to do the same. As with the earlier revolutions, the Robotics Revolution will be driven by individuals with the right combination of creativity to imagine new applications, the technical knowledge to construct them, and the entrepreneurial spirit to transform their creations into viable businesses. Therefore, we have begun to engage young men and women in Robotics by building a university-based community of entrepreneurial robotics students nationwide through a Robotics Innovations Competition and Conference.

The Robotics Innovations Competition and Conference, held Nov. 7-8, 2009, challenged students to design and build robots to perform useful and novel tasks through a university-level competition. Entrants were judged primarily on the extent to which they met existing needs or created new markets, and secondarily with respect to design and analysis, implementation skill, and business plans. While robotics competitions exist at the K–12 and university levels, these are notably based on games with a fixed set of rules. Existing games do not sufficiently challenge the entrepreneurial student; what was needed was a competition that emphasized the engineering of solutions to open-ended real-world problems and that invites creativity by an open competition based on the intellectual and commercial and/or humane aspects of the solutions. The competition was coupled with a student-centered conference at which all participants had opportunities to present and publish their innovative ideas by virtue of poster presentations as well as an audience presentation and robot demonstration. Undergraduate and Graduate students from many disciplines participated in the competition and conference. A preliminary report of the event was presented in [8].

Figure 1. RICC Competitor poster showing a potential product.

2. Overview, Mission, Objectives, Outcomes

2.1 Overview

Having identified "inventing new things for robots to do" as the next logical step in the development of robotics, we are compelled to actions to accelerate the process by inspiring more of our students to think about new applications. A degree in Robotics[7] would provide the technical skills needed to build a wide variety of robots. However, not everybody wants such a degree; hence it is important to provide a forum that attracts broad participation. The successful robotics innovation and invention team almost certainly will comprise a multidisciplinary group of engineering and computer science students, undergraduates and graduate students. The RICC is a testing ground and springboard for the dissemination of this combined vision and approach to fundamentally transform Science, Technology, Engineering, and Mathematics (STEM) education in universities.

2.2 Mission Statement

The main reasons for this effort are summarized below:

Interdisciplinary: It seems obvious that designing devices that marry sensing, computing, and acting requires individuals who have a background in electrical engineering, computer science, and mechanical engineering. Design of robots requires emphasis on system integration that goes beyond that usually included in an undergraduate study in the traditional disciplines.

Figure 2. RICC self-lifting robot.

New economic opportunities: The drop in prices of the various components needed to build robots has the potential to generate a robotics "boom" where independent innovators flood the market with new gadgets. Unlike biomedical products, for example—which usually require significant initial investment, robotics is a natural domain of innovative small businesses. The economic opportunities should be enormous and robotics engineering programs need to be designed to foster an innovative entrepreneurial spirit among the students.

Attracting students: Robotics is something that everyone can relate to. It is well understood to involve a broad range of automatic and autonomous devices (industrial robots, mobile robots, and vacuum cleaners, for example) and robotics resonates strongly with a generation brought up with computers and the Internet. Robotics competitions have proven to be THE way to generate excitement about science and technology among high school students. Thus, robotics is an important tool for attracting more (and more diverse) students into STEM disciplines.

- Botball robotic soccer competitions have included over 34,000 students to date [2].
- BattleBots IQ (numbers unknown) has been going on since 2000, claiming to have "hundreds" of high schools involved [3].
- Other events, such as Robocup and Boosting Engineering, Science and Technology (BEST) Robotics with 8,000 students yearly [4], also illustrate the high level of interest.
- The robots.net Robotics Competition page lists 88 competitions in 2006 alone [5]. Note that FIRST counts as a single entry, despite its multiple dates and venues.

The potential of a robotics competition format to have a broader impact with respect to increasing the interest and diversity of students enrolling for STEM degree programs is well demonstrated in the results of the 2005 study "More than Robots: An Evaluation of the FIRST Robotics Competition Participant and Institutional Impacts"[6].

2.3 Objectives

Our objectives are linked to the specific community building activities that we undertook:

- Robotics Innovations Competition and Conference Planning Workshop
- Robotics Innovations Competition and Conference (RICC)

The RICC Planning Workshop gathered representatives from a core group of Northeast region universities. The workshop objectives were to disseminate our vision, establish ground rules for the competition, create a detailed schedule, and seek assistance from this new community to create the first regional RICC to take place two years from that meeting.

The RICC activity was a two-day event during which entries were on display and presentations were given. Judges from industry and academia evaluated the entries and awarded several prizes in categories, such as innovation, quality of design, as well as 1st, 2nd, and 3rd overall. Other conference activities included presentations by faculty and industry. Educational presentations for students included topics related to the commercialization of products and entrepreneurship. The objective of the RICC is to reward all participants for their hard work, expose the best ideas to industry representatives, give students useful feedback on their inventions, and foster teamwork within each group, collegiality across teams, serve as a milestone in participants' education, and increase public support for science and engineering generally.

2.4 Outcomes

We feel the RICC transforms STEM education with the immediate outcome of accelerating the development of an innovative workforce, a workforce that is focused on imagining new things for robots to do. This outcome is a direct result of the objective of creating a yearly competition and conference, with the thrust "inventing new things for robots to do" in which college students present their own inventions. The creation of a community of regional universities that will participate in and host this yearly event is the other core outcome of this project. The outcomes of the Robotics Innovations Competition and Conference are two-fold:

- Stimulate the student's imagination to think about new robotics applications and encouragement to develop their ideas into working prototypes, and

- Bring the students' work to the attention of people in industry who may see opportunities to further develop the students' ideas and to provide a forum where the students can communicate with industry representatives to learn about needs and new problems.

3. Activities and Findings

We organized a Steering Committee comprising representatives from iRobot Corporation, Foster-Miller Inc., University of Massachusetts Lowell, Clark University, Roger Williams University, Hewlett-Packard Company, Heartland Robotics, Tufts University, and The Onstott Group as well as members of the WPI community. The Steering Committee met periodically to discuss major RICC format concerns. The goal was to identify and determine the proper format for the RICC to insure the RICC would meet our intended goals for community building. An internal University Steering Committee Faculty and RICC support personnel met weekly to discuss RICC issues to insure that organizational details and event particulars were being addressed in a timely fashion.

Other activities were conducted that were not explicitly part of the project proposal. One of these was the formation of an undergraduate student project team to help plan the event. The team organized its work around a focus question: What are the necessary developments in order to

build a recurring community-based robotics conference and competition? The students surveyed

similar events, defined the project vision, and focused on management and implementation issues. They produced a Final Report and Management Handbook describing their findings and recommendations. These include sections on personnel roles and responsibilities, communication and work flow, important contact information, sample forms, and a prototype website design.

A second undergraduate project team has continued this work. Its focus question is: How does one execute a competition and conference so that it fosters a community that features strong involvement from both academia and industry? Data was gathered by interviewing faculty and industry members from the RICC Steering Committee, and administering a survey to the undergraduate student body at WPI. In addition, RICC website visit statistics and visitor location data also became available. This data was reviewed to assess if academia and industry needs were being met. The 2 day RICC format was presented, with the conference being held the 1st day comprising a luncheon, speaker topics, student poster session, and a socializing "robot-building" fun community-building activity. The 2nd day would be the competition proper with the competitor robots being presented followed by an awards ceremony. The student project found that the RICC in its current form is sufficient for its intended participants: students, academic institutions, and industry professionals, with any minor changes made in subsequent years. During the analyzed period there were 14650 website visits from unique domains across the United States as well as from foreign countries.

A third undergraduate project team was also able to take advantage of the audience at the actual RICC event held on Nov. 7-8, 2009. This project's goal was to look into "bioethics" to see what

ethical aspects regarding robotics and biological issues should be considered. A "Bioethics survey sheet" was given to each attendee with a number of questions which were then filled out and left in a collection box for analysis by the student project team. The results of this survey will not be reported herein since it is considered outside of the scope of this paper.

An "RICC survey sheet" was also included in the actual RICC attendee package and they were asked a number of questions regarding the RICC format and event activities conducted. The goal was to see what potential improvements could make the RICC even more valuable as a community building event. The results of this survey are reported below.

4. Outreach Activities

This project conducted outreach through the following mechanisms:

Media: The Robotics Innovations Competition and Conference press release was sent to a range of local and national media. IEEE sponsorship of the RICC event facilitated advertising in multiple magazines such as IEEE Potentials (student membership) and IEEE Robotics & Automation Magazine, thus gaining worldwide exposure. Mailing the RICC poster by USPS to our mailing list of 334 universities and 382 companies for potential conference attendees helped advertise the event. E-mailing the RICC poster to addresses such as on the robotics-worldwide list (over 3000), New England Manipulation Society (117), RICC website interest (65), RICC-Announce (109), RICC-Steering (33), Georgia Tech Cyber-Physical Systems Summer School Attendees (90) provided additional exposure. For example, RICC competitors from Mexico City and Egypt demonstrated international exposure.

Non-STEM Universities: We included non-STEM universities, such as Clark University and Roger Williams University, on the RICC Steering Committee; the latter entered a team in the competition.

Empowering Leadership (EL) Alliance: We are taking part in EL Alliance planning activities and hope to attract RICC participants from under-represented groups through this effort.

Web Sites: http://ricc.wpi.edu/ is the main site for the project. It explains the Robotics Innovations Competition and Conference, permits registration, acknowledges sponsors, links to media, and provides details on the event. The website hit statistic analysis shows over 139500 hits from domains across the United States and foreign countries. Social networking site http://ricc-at-wpi.ning.com/ allowed competitors and others to interact, chat and view pictures.

5. Outcomes

5.1 Attendees and Competitor Robots

There were 170 registrations to the First Annual 2009 RICC via the internet website process. Of these, 150 attendees signed in at the registration table. There were 14 registered competing robots, although only 10 ultimately competed due to various circumstances.

5.2 Results of RICC Survey

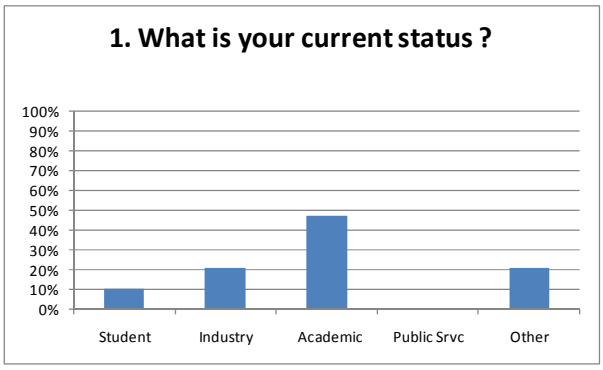
The survey was distributed to all attendees who signed in during the registration process. The following table represents the tabulated results for the 19 respondents. Note that not all people answered all questions; however the results are interesting and certainly indicative of a successful event, and some individuals made suggestions which appear in the four numbered items below the table itself.

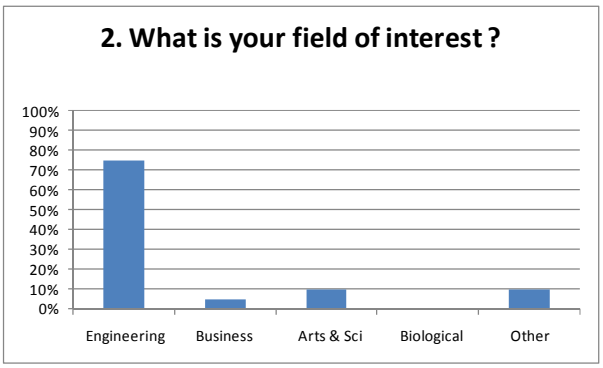
1. Which of these categories best fits your current status?	**Student**		**Industry**		**Academic**		**Public Srvc**		**Other**	
	2	11%	4	21%	9	47%	0	0%	4	21%
2. What is your filed of interest?	**Engineering**		**Business**		**Arts & Sci**		**Biological**		**Other**	
	15	75%	1	5%	2	10%	0	0%	2	10%
3. Future RICC events should be held in which time frame?	**Jan, Feb, Mar**		**Apr, May, Jun**		**Jul, Aug, Sep**		**Oct, Nov, Dec**		**Does not matter**	
	3	15%	3	15%	4	20%	5	25%	5	25%
4. The current 2-day format worked well this year	**Strongly Disagree**		**Disagree**		**Neutral**		**Agree**		**Strongly Agree**	
	1	5%	3	16%	5	26%	9	47%	1	5%
5. Highlighting innovative and creative robots is a good idea	**Strongly Disagree**		**Disagree**		**Neutral**		**Agree**		**Strongly Agree**	
	0	0%	0	0%	0	0%	4	21%	15	79%
6. Establishing a Competition theme is a good idea, rather than allowing any type of robot to be created and to compete	**Strongly Disagree**		**Disagree**		**Neutral**		**Agree**		**Strongly Agree**	
	0	0%	0	0%	4	22%	12	67%	2	11%
7. Robotics Industry involvement was	**Too little**		**Slightly too little**		**Just right**		**Slightly too much**		**Too much**	
	4	24%	7	41%	6	35%	0	0%	0	0%
8. University Industry involvement was	**Too little**		**Slightly too little**		**Just right**		**Slightly too much**		**Too much**	
	2	13%	2	13%	11	69%	1	6%	0	0%
9. The number of industry related talks was	**Too little**		**Slightly too little**		**Just right**		**Slightly too much**		**Too much**	
	0	0%	3	18%	11	65%	3	18%	0	0%
10. The number of robot demonstrations was	**Too little**		**Slightly too little**		**Just right**		**Slightly too much**		**Too much**	
	1	6%	7	44%	8	50%	0	0%	0	0%
11. The LEGO design and build activity helped to build a sense of community	**Strongly Disagree**		**Disagree**		**Neutral**		**Agree**		**Strongly Agree**	
	0	0%	1	11%	4	44%	1	11%	3	33%
12. The RICC should include workshops to help attendees gain more robot building knowledge	**Strongly Disagree**		**Disagree**		**Neutral**		**Agree**		**Strongly Agree**	
	0	0%	4	21%	5	26%	8	42%	2	11%
13. If you are a University student , "I am interested in entering a robot in next year's RICC"	**Strongly Disagree**		**Disagree**		**Neutral**		**Agree**		**Strongly Agree**	
	0	0%	0	0%	2	50%	2	50%	0	0%
14. I would like to attend RICC next year	**Strongly Disagree**		**Disagree**		**Neutral**		**Agree**		**Strongly Agree**	
	0	0%	0	0%	0	0%	14	82%	3	18%

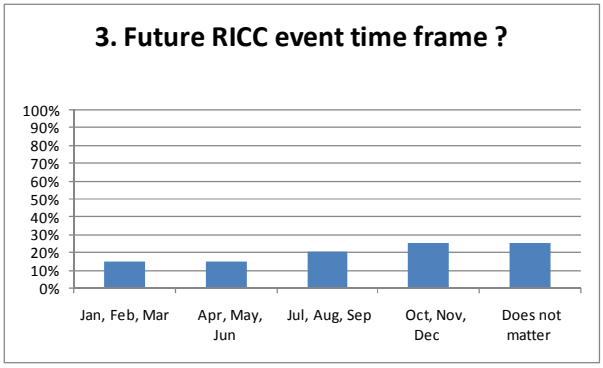
Other Comments

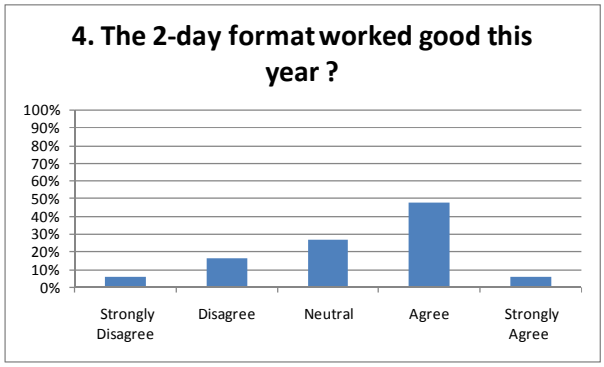
1. As parents we enjoyed the opportunity to learn more about the field of study our son has chosen and see exactly what is going on. The conference talks were both informative and entertaining and at a level where we could follow what is being presented. A as with all events we have attended at WPI, it was well organized, excellent handouts and very welcoming.
2. Robot display area felt a little too crowded – use a bigger space
3. It would be nice to have robot demonstrations from industry
4. LEGO Design & Build event was great

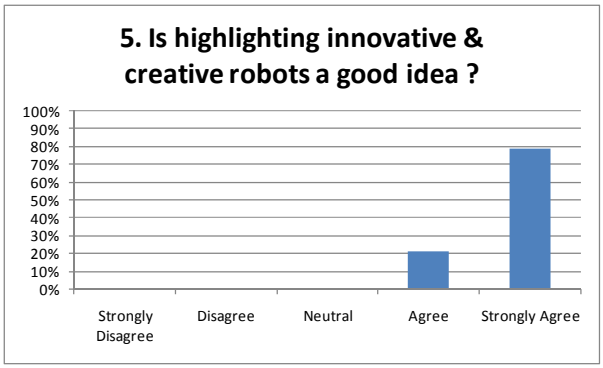
The barchart graphs, shown below, provide a visual summary of the results of the table above.

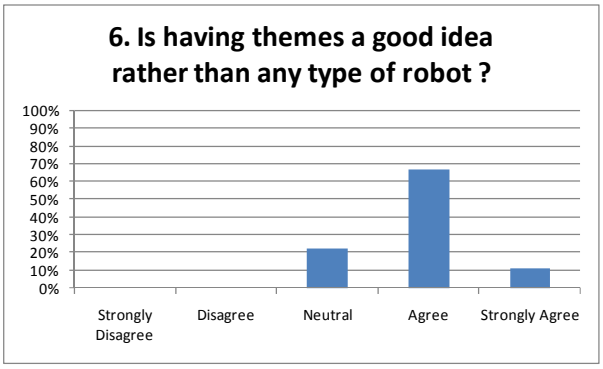

1. What is your current status ?
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Student
Industry
Academic
Public Srvc
Other

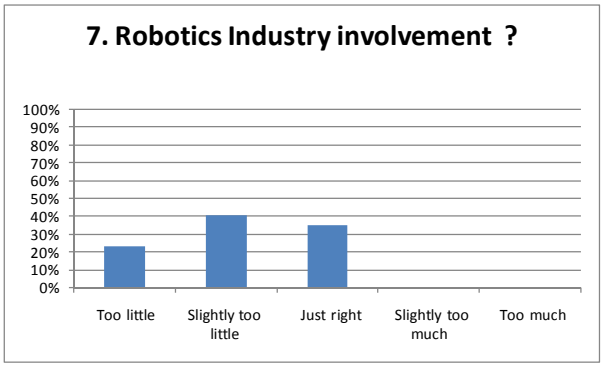

2. What is your field of interest ?
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Engineering
Business
Arts & Sci
Biological
Other


3. Future RICC event time frame ?
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Jan, Feb, Mar
Apr, May, Jun
Jul, Aug, Sep
Oct, Nov, Dec
Does not matter


4. The 2-day format worked good this year ?
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Strongly Disagree
Disagree
Neutral
Agree
Strongly Agree


5. Is highlighting innovative & creative robots a good idea ?
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Strongly Disagree
Disagree
Neutral
Agree
Strongly Agree


6. Is having themes a good idea rather than any type of robot ?
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Strongly Disagree
Disagree
Neutral
Agree
Strongly Agree


7. Robotics Industry involvement ?
100%
90%
80%
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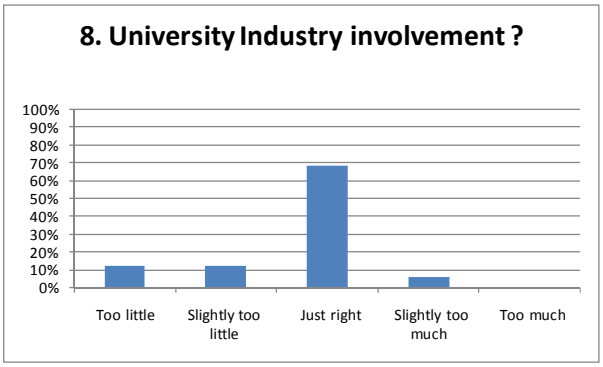
Too little
Slightly too little
Just right
Slightly too much
Too much


8. University Industry involvement ?
100%
90%
80%
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40%
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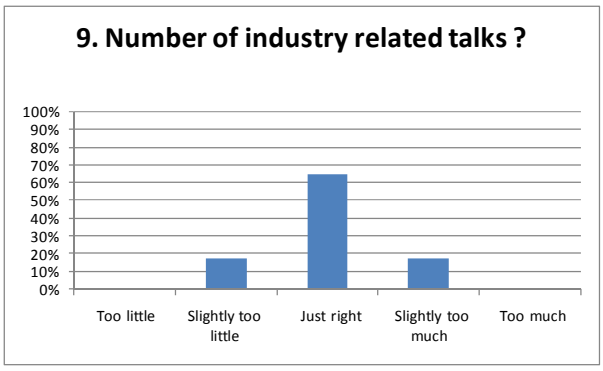
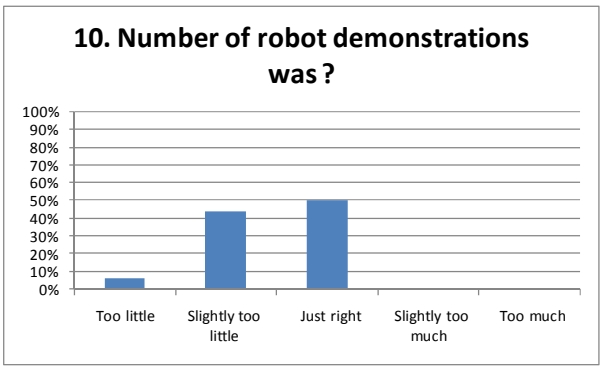
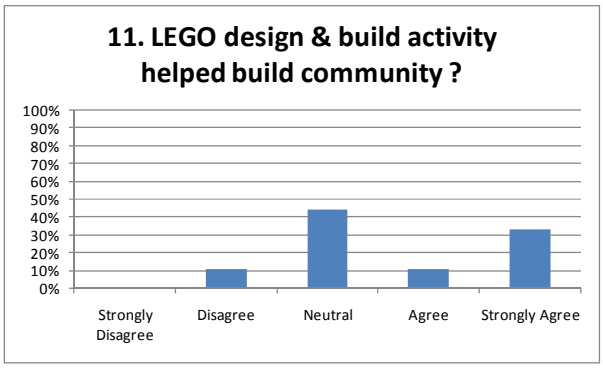
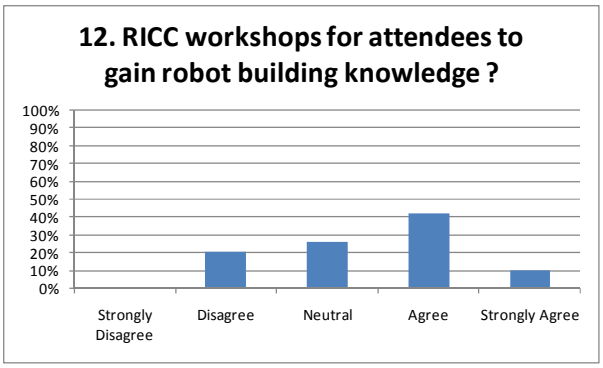
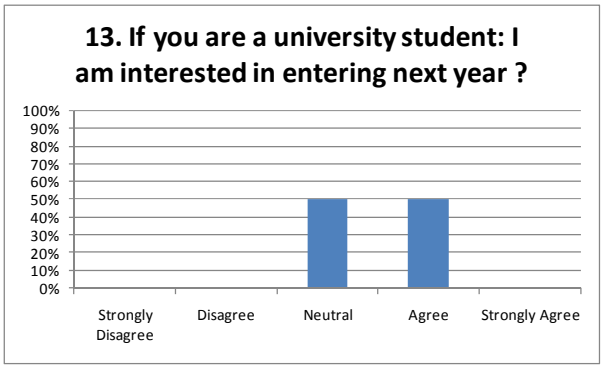
20%
10%
0%
Too little
Slightly too little
Just right
Slightly too much
Too much

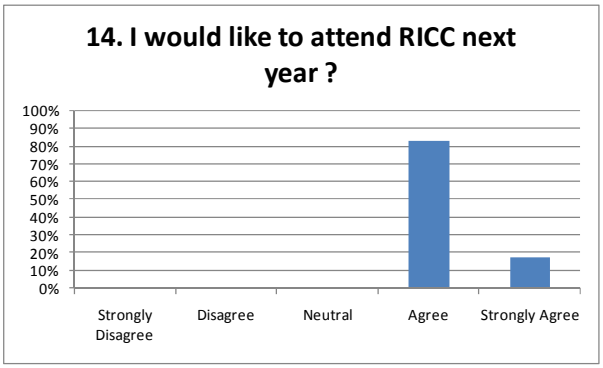












6. Conclusions and Recommendations

6.1 Conclusions

Analyzing the survey leads to a number of conclusions:

- RICC attendees were largely academic types with “industry” and “other” also a large percentage showing the success of the RICC regarding community building. The number of attendees is also indicative of the community robotics interest. The largest percentage of attendees had an interest in engineering.
- Future RICC event timeframe indication is that October-December is a good choice, with July-September next; however, some respondents did not feel this was too important.
- A 2-day format was felt to have worked well, with some other respondents being neutral.
- Highlighting innovation and creative robots around a theme is felt to be a good idea.

- Robotics industry involvement is felt to have been “just right” or “slightly too little”, while university involvement was “just right”.
- The number of industry related talks was felt to be “just right”, while, the number of robot demonstrations was felt to be “just right” or “slightly too little”.
- A LEGO design & build activity event was felt to help build community. Adding RICC workshops to build knowledge was deemed primarily “neutral” to “agree/strongly agree”.
- The university students who completed the survey indicate “neutral” and “agree” regarding entering next year’s RICC.
- Finally, all respondents indicate that they would like to attend the RICC next year with “agree” to “strongly agree”.

6.2 Recommendations

Highlighting innovation and creative robots with a specific theme should be repeated.

RICC workshops and LEGO design & build activity worked well and should be included.

7. Overall Conclusion

The Robotics Innovations Competition and Conference (RICC) succeeded in building community between Academia and Industry. This was accomplished by involving attendees form Industry, Academia, and Media as well as parents of competing students and generally interested parties including K-12 teachers as well as students with robotic interests. It also was accomplished by having a number of robotic industry representative speakers as well as academic types covering topics of interest to everyone in the diverse community.

The RICC concept is a worthwhile one, and based on the successful response to our survey we are planning the next RICC for April 2011 in conjunction with the IEEE Technologies for Practical Robotics Applications (TePRA) conference.

8. Acknowledgements

The support of the National Science Foundation under award # CNS-0722218 is gratefully acknowledged. The authors also wish to thank the members of the RICC Steering Committee who have worked hard to bring our vision of the event to reality. In addition, we thank the anonymous reviewers for their constructive comments that have improved the presentation of the paper.

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