

Longitudinal Growth of VEX Robotic Competitions in Utah and the Rocky Mountain Region

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ABSTRACT

The Utah State University VEX Robotics Team (USUVRT) is in its fifth year of promoting the VEX Robotics Competition in the Utah and Rocky Mountain Region. The Robotics Education and Competition Foundation (RECF) annually hosts the VEX World Championships to identify and award the best middle school, high school, and college robotics teams. The USUVRT has partnered with the Rocky Mountain NASA Space Grant Consortium to promote science, technology, engineering, and mathematics (STEM) activities via VEX Robotics to middle and high school students in the Utah and Rocky Mountain Region. This paper discusses the outreach methods qualifying system used by the USUVRT over the past five years.

VEX ROBOTICS COMPETITIONS AND STEM

VEX Robotics is the largest and fastest growing competition for middle and high school students in the world (Innovation First International, 2013; Robinson and Stewardson, 2012; Robotics Education and Competition Foundation, 2010). One reason for their success is due to the sporting event mentality. A typical tournament may consist of 40-60 matches where two teams compete against two other teams head to head. It is an exciting platform that keeps teams interested and motivated to compete. The 2012-2013 season is the eighth season of competitions for VEX. This season there are over 7,000 teams from around the world competing in approximately 400 local VEX Robotic Competitions (VRCs). Figure 1 shows the number of teams competing in VEX compared to similar popular robotics competitions. VEX has established national partnerships with Intelitek, Technology Student Association (TSA), and Project Lead the Way (PLTW) (Robinson and Stewardson, 2012). By using

these partnerships to reach schools that are already trying to increase student interest in science, technology, engineering, and math (STEM), VEX has been able to continue to offer an exciting avenue for studying STEM to more students each year.

Numerous studies have investigated robotics competitions in general to evaluate the impact that competitions have on students (Hendricks C.C., Alemdar, M., & Ogletree, T.W., 2012; Nugent, Barker, Grandgenett, & Adamchuk, 2010; Nourbakhsh, Crowley, Bhave, Hamner, Hsiu, Perez-Barguest, Richards, & Wilkinson, 2005; Robinson, M., 2005; McIntyre, 2002; Kolberg & Orlev, 2001; Sklar, Johnson, & Lund, 2000). Nugent, et. al., (2010) concluded by stating “through hands-on experimentation, such technologies can help youth translate abstract mathematics and science concepts into concrete real-world applications.” More recently Hendricks et. al., (2012) surveyed students and team leaders that participate in VEX. The researchers surveyed those students and team leaders about student interest in STEM courses and careers after participation in VEX. Although it could be argued their research design and data is suspect, the authors conclude that students and team leaders “perceive that participation positively affects student interest in STEM courses and careers” (Hendricks et. al., 2012). Although there are very few studies that specifically investigate VEX, the studies that have been conducted, are showing that VEX is meeting the goal of increasing student understanding and interest in STEM.

UTAH STATE UNIVERSITY VEX ROBOTICS TEAM

In 2009 the Utah State University VEX Robotics Team (USUVRT) began to compete in the VEX Robotics College Challenge. The team is housed in the technology and engineering education

(TEE) program in the College of Agriculture and Applied Sciences. The USUVRT has competed at the world championship every year since the first college challenge in 2009. The College Challenge allows the USUVRT to compete against top universities from around the world. The USUVRT has consistently been one of the top teams from the United States, winning the Think Award (2010) and the Create Award (2012) in past seasons.

When the Utah State University VEX Robotics Team began, there were no high school or middle school teams in the region. The USUVRT and advisor Gary Stewardson, professor at USU, began to develop strategies to provide STEM experiences through VEX Robotics in Utah and the Rocky Mountain Region. With the support of the Rocky Mountain NASA Space Grant Consortium and Hill Air Force Base, the VEX Robotics Competition movement began in the region.

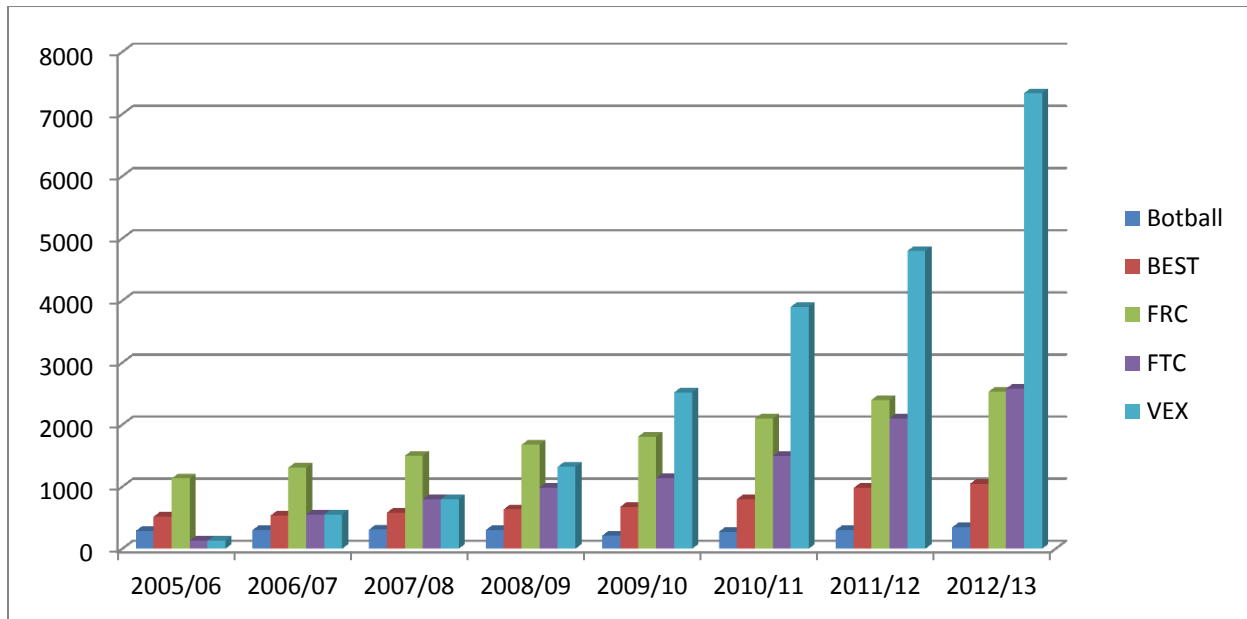


Figure 1. The number of teams competing in select competitions by year.

OUTREACH METHODS – HOSTING LOCAL VRCS

The first step of establishing a presence for VEX in the rocky mountain region was to establish teams to compete in a local VRC. The USUVRT created the Design Academy (DA) (Robinson and Stewardson, 2012) to allow students from the region to have a laboratory to design and build robots. The Design Academy started in the fall of 2009 with approximately 12 middle school and two high school students. Two high school teams from the DA competed in the first local VRC in Utah on January 9, 2010 with seven other teams from the region. Two qualifying spots for the VEX Robotics World Championship were awarded at this tournament. One team from the Design Academy was on the winning alliance at the tournament and won the

chance to compete at the world championship, although due to financial reasons did not attend. The DA has seen steady growth since its creation; reaching its maximum number of students during the 2011-2012 season with 24 students including a short waiting list. The DA had four teams competing during that season. During the spring of 2012 the TEE program transitioned from the College of Engineering to the College of Agriculture and Applied Sciences, and the Design Academy moved into a different laboratory. The new laboratory was smaller and unable to support the same number of students. Therefore, during the 2012-2013 season, the DA only had 14 students representing three teams. Figure 2 charts the success of the DA by the number of teams and students participating each year.

The Utah State VEX Robotics Team continues to be involved in the local VRCs taking place in the region. During the 2012-2013 season, Utah hosted seven local VRCs, the most since the USUVRT began hosting tournaments in 2010. Rick Tyler, a Robotics Education and Competition Foundation regional representative stated that Utah holds the most local VRCs per number of teams out of any region in the world (personal communication, April, 2012). For a complete list of number of teams and tournaments in Utah see Figures 3 and 4 respectively. The USUVRT believes that the growth and ability to host a large number of VRCs is due to the unique format used to determine which teams qualify for the annual VEX World Championship.

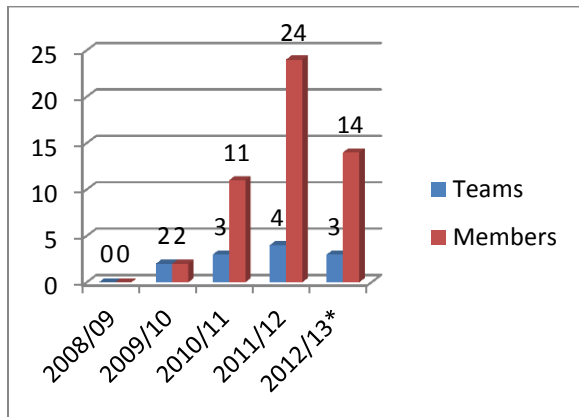


Figure 2. The number of Design Academy members and teams by year. *Due to new lab size restrictions the number of students allowed was reduced.

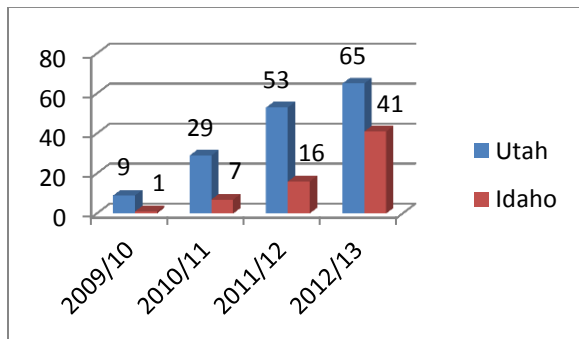


Figure 3. Total number of teams participating in VRC in Utah and Idaho by year.

Although a majority of the local VRCs for the region are held in Utah, there are local VRCs in Idaho. At the first local VRC in Utah in 2010,

one team from Idaho competed, and also qualified for the world championship. During the 2011-2012 season, Idaho hosted its first local VRC. There were 12 teams that competed at the tournament. Seven of those teams were from Idaho. Now in its fourth year of being involved in VEX, Idaho hosted two tournaments and had 41 teams in the state. For a complete list of the number of teams, tournaments, and average number of teams competing at local VRCs see Figures 3 and 4 respectively.

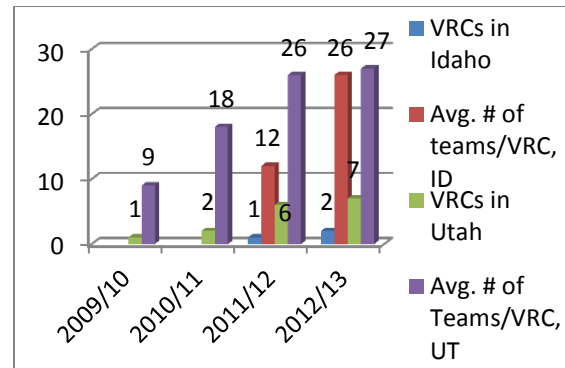


Figure 4. Number of local VRCs held and the average number of teams participating in each VRC in Utah and Idaho.

After the successes of Utah and Idaho, the RECF wanted to establish teams in Wyoming. The USUVRT assisted in this effort. When the USUVRT team began its outreach, there were zero teams in the southwest region of Wyoming. During the 2012-2013 season two teams from Evanston began to compete at local VRCs in Utah. These two teams are only the beginning of what can become the third state in the rocky mountain region to add to the growth in VEX Robotics.

OUTREACH METHODS – TSA VEX

In 2010 VEX partnered with the Technology Student Association. Each season TSA is able to host its own local and state VRCs. The USUVRT was instrumental in starting the first state TSA VEX VRC tournament in 2010. At this tournament six teams participated, but since then the tournament has grown significantly. The number of TSA teams has increased so that during the 2012-2013 season, two state tournaments were held; one for middle school and one for high school. There were eight

middle school teams and 27 high schools teams that competed in the respective tournaments. The growth of TSA VEX in Utah can be seen in Figure 5.

Idaho held its first TSA VEX tournament during the 2011-2012 season. There were 12 teams that competed in the tournament. During the 2012-2013 season there were 15 teams that competed; Figure 5 shows the complete number of teams by season. The teams competing in Idaho and Utah TSA VEX have seen great success on a national level. To date, there have been three National TSA VEX tournaments, and three National TSA VEX Championships returning to Utah. The fourth National TSA VEX tournament will be held in June 2013, and Utah is in the running for its fourth straight national championship.

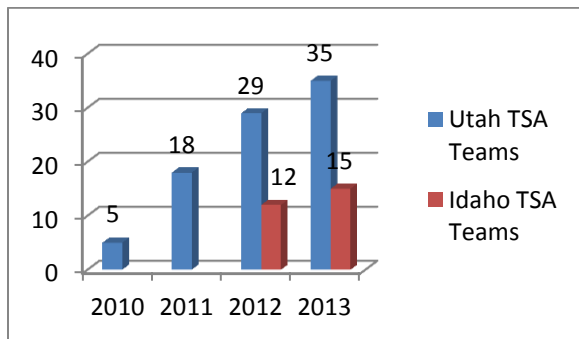


Figure 5. Number of teams that competed in the Utah and Idaho TSA VEX Tournaments.

OUTREACH METHODS – PRESENTATIONS, PUBLICATIONS, AND WORKSHOPS

In addition to hosting the Utah and Mountain Region VEX Robotics Championship and coaching the Design Academy, the USUVRT also promotes VEX through state, national, and international presentations. Presentations of have been made at the International Technology and Engineering Educators Association (ITEEA) annual conferences to promote VEX and its benefits for STEM education. Members of the USUVRT also write national and international publications. Robinson and Stewardson (2012) published a journal article in *the Technology and Engineering Teacher* thoroughly explaining a curriculum developed to teach the skills necessary to be successful in VEX. This curriculum is used in the Design Academy and

schools throughout Utah, Idaho, and Georgia. For a complete list of presentations and publications see Tables 1 and 2 respectively.

The USUVRT also hosts workshops to promote VEX Robotics. The first workshop was in cooperation with 4-H. More recently, the USUVRT partnered with the National Defense Education Program through Hill Air Force Base and Intelitek to conduct summer workshops at USU. Teachers throughout the state of Utah are invited to USU for three days to receive instruction from Intelitek on starting a VEX program at their school. These teachers must come from schools that have no previous experience in VEX. Teachers also bring two students from their school to the workshop. From experience it was seen that a student that is excited about VEX can encourage a teacher to pursue the creation of a VEX team and assist with recruiting students at their school. Each teacher/student team receives a starter bundle to work with during the workshop. This bundle includes everything to design, build, program, and control a basic robot. After completion of the workshop, the starter bundles are sent home with the teachers to give them a boost at starting a VEX team. Teachers that participate in this workshop are requested to sign up a team to compete in at least one local VRC the following school year. These workshops have ensured the continued growth of VEX in the region; a complete list of workshops can be seen in Table 3.

UTAH AND ROCKY MOUNTAIN REGION VEX ROBOTICS QUALIFYING CHAMPIONSHIPS

The Utah and rocky mountain region has a unique qualifying method for the world championships. VEX limits the number of teams that can qualify from each state or region. VEX prefers that each state holds a state championship tournament where all teams from the state compete. The USUVRT believes that this method of determining the best teams in the state restricts growth. Under this method, only one or two local VRCs are world qualifiers and “really matter”. As a result, why spend money and effort to attend a “practice VRC”? Since VEX Robotics is similar to a sporting event, a

Table 1. List of presentations by the USU VEX Robotics Team.

Presenter(s)	Title	Location	Date
Robinson, T.	VEX Robotics Demonstration	TSA Fall Leadership Conference, West Jordan, UT	October 15, 2011
Stewardson, G.	The Exciting World of VEX Robotics and How to get Started	TSA Fall Leadership Conference, West Jordan, UT	October 15, 2011
Stewardson G, & Robinson, T.	Utah State Curriculum Resources: Robotics, Energy, and Manufacturing	Utah Technology and Engineering Summer Conference, Orem, UT	June 15-16, 2010
Stewardson, G. & Robinson, T.	Exciting the Next Generation through Robotic Competitions	73 rd ITEEA Conference, Minneapolis, MN	March 24-26, 2011
Stewardson, G.	VEX Robotics: How to Get Started	Northern Utah Academy for Math, Engineering, and Science, Layton, UT	November 12, 2010
Robinson, T	Hands on VEX Demonstration	Northern Utah Academy for Math, Engineering, and Science, Layton, UT	November 12, 2010
Stewardson, G.	Leading Through VEX Robotics	TSA Fall Leadership Conference, West Jordan, UT	October 9, 2010
Robinson, T., & Helm, B.	Hands on VEX Demonstration	TSA Fall Leadership Conference, West Jordan, UT	October 9, 2010
Stewardson, G.	VEX Robotics Exhibition	Utah Technology and Engineering Summer Conference, Pleasant Grove, Utah	June 15-16, 2010
Thomas, A.	Utah State Design Academy Project	Proceedings of the 16 th Annual Fellowship Symposium. Sponsored by the Rocky Mountain NASA Space Grant Consortium, Utah State University, Logan, UT	May 12, 2010
Stewardson, G.A., & Williams, S.	Developing 21st Century Skills Through Robotics	72 nd ITEEA Conference, Charlotte, NC	March 18-20, 2010
Stewardson, G. & Williams, S.	VEX Robotics for the High School	Utah Technology and Engineering Summer Conference, Pleasant Grove, UT	June 17-18, 2009

system similar to an athletic conference schedule was developed. In this method teams would have a regular season followed by state playoffs. Under this system teams are encouraged to add VRCs to the conference schedule. All VRCs are important and used to qualify for state playoffs.

In addition the USUVRT feels that the current method does not allow teams to compete in enough local VRCs to design and build the best robot to compete at the world championship.

Teams will build better robots if the robot goes through several design iterations, fully utilizing a complete design process. The USUVRT has noticed that a design change is not fully tested until it competes in a full tournament, and has competed against other robots in a real match. In discussion with Utah coaches it was stated that teams prefer not having a state tournament with every team competing. They feel that during qualifying matches a top team can be paired with a poor team and be required to

Table 2. List of publications by the USU VEX Robotics Team.

Author(s)	Title	Location	Date
Robinson, T. P. & Stewardson, G.A.	Exciting Students Through VEX Robotic Competitions	The Technology and Engineering Teacher 72(2) 15-21	October, 2012
Robinson, T. P.	The Growth of VEX Robotics Competitions in Utah and the Rocky Mountain Region	Proceedings of the 18 th Annual Fellowship Symposium. Sponsored by the Rocky Mountain NASA Space Grant Consortium, Utah State University, Logan, UT	May 9, 2012
Robinson, T. P.	Implementing VEX Robotic Competitions in the Rocky Mountain Region	Proceedings of the 17 th Annual Fellowship Symposium. Sponsored by the Rocky Mountain NASA Space Grant Consortium, Utah State University, Logan, UT	May 11, 2011
Williams, S.	Providing STEM Experiences Through Robotic Competitions for Students and Teachers Grades 6-12	Proceedings of the 16 th Annual Fellowship Symposium. Sponsored by the Rocky Mountain NASA Space Grant Consortium, Utah State University, Logan, UT	May 12, 2010
Robinson, T. P.	Development of a Secondary School Curriculum for Competitive VEX Robotic Teams Meeting in Formal and Informal Learning Environments (M.S. Project)	Utah State University, Logan, UT	2010

Table 3. List of workshops presented by the USU VEX Robotics Team.

Presenter(s)	Title	Location	Date
Clarke, R. & Stewardson G.	Introduction to Competitive VEX Robotics	Utah State University, Logan, UT	July 31-August 2, 2012
Clarke, R. & Stewardson G.	Introduction to Competitive VEX Robotics	Utah State University, Logan, UT	July 6-8, 2011
Williams, S, Helm, B., Stewardson, G.	4-H VEX Robotics Workshop	Utah State University, Logan, UT	July 20-22, 2009

compete against two other good teams. When this occurs, a top team partnered with a poor team is at a disadvantage, and may finish qualifying rounds with a record that is not reflective of their team’s robot; causing the team to be seated lower and possibly being chosen by a weaker alliance partner. The USUVRT and Gary Stewardson created a format that

minimizes these concerns and allows teams to reach a greater potential for success.

In this athletic conference style system, teams compete in any number of local VRCs in the region during a regular season. Teams earn points toward competing for the world

Table 4. Points earned based on final outcomes toward the Utah and Mountain Region Championship

Points earned by teams based on final outcomes			
<i>Awards</i>	<i>Level 1 Tournament (12-23 teams)*</i>	<i>Level 2 Tournament (24-31 teams)*</i>	<i>Level 3 Tournament (32-41 teams)*</i>
Champion	12 pts	16 pts	20 pts
Finalist	6 pts	8 pts	10 pts
Excellence	6 pts	8 pts	10 pts
Programming Skills, 1st	8 pts	12 pts	16 pts
Programming Skills, 2nd	4 pts	6 pts	8 pts
Programming Skills, 3rd	2 pts	3 pts	4 pts
Robot skills, 1st	8 pts	12 pts	16 pts
Robot skills, 2nd	4 pts	6 pts	8 pts
Robot skills, 3rd	2 pts	3 pts	4 pts

Chart used by permission from the Engineering and Technology Curriculum Team & Gary Stewardson, (2012).

qualifying state tournaments. Every team that participates in a local VRC automatically earns one point for participation. Additional points are earned based on the size of the local VRC and based on the final outcomes for tournaments and seeding position after qualifying matches. Tables 4 and 5 show the number of points earned for each outcome and seeding position respectively for the 2012-2013 season (Engineering and Technology Curriculum Team, 2012). For example, Team 1234 competing at a Level 2 Tournament might earn the following points. One point would automatically be scored for competing. If Team 1234 finished the qualifying matches ranked first, they would earn eight points. If the team became tournament champions, they would earn an additional 16 points. If Team 1234 competed in the Robot Skills challenge, and finished in second place, they would earn six points. With the above scores, Team 1234 would have earned a total of 31 points.

Teams can compete in as many or as few local VRCs as they would like, although it appears that the top teams compete in almost all of the local VRCs. Because not all teams can afford to compete in all tournaments it was believed to be unfair to add the scores from every local VRC to a team’s qualifying score. Therefore only the top two tournament scores along with each single participation point are counted towards the teams qualifying points for the state tournament. After all of the local VRCs are completed for the

season, the top 24 to 31 teams are invited to participate in the world qualifying state and region VEX championships. For the 2012-2013 season, Utah was allotted six world slots. As a result, two state and regional tournaments were required to fill these slots. Both tournament champions and excellence award winners from both tournaments qualified for the world tournament. There were 29 teams that competed in both tournaments. Two of the six available world championship slots were won by DA teams. The high school team won an excellence award and a middle school team was tournament champions.

2011-2012 was the first season for the qualifying system. After the initial season some changes were made for the 2012-2013 season. At a Level 2 Tournament, points were only given to the top eight teams after qualifying rounds at a local VRC. During the second season this number of teams was increased to 12. For the 2013-2014 season it was decided that because there are more local VRCs being held, that a team’s top three tournament scores would count towards the championship qualifying point system. The USUVRT credits this qualifying system for helping create a region with the most local VRCs per number of teams, and for creating world class robots. The problem now is to find enough weekends evenly spaced to schedule all of the VRCs that teams wish to host. As mentioned earlier this is not the only

Table 5. Points earned based on final outcomes toward the Utah and Mountain Region Championship

Points earned by teams based on seeding after qualifying rounds			
<i>Seeding</i>	<i>Level 1 Tournament (12-23 teams)*</i>	<i>Level 2 Tournament (24-31 teams)*</i>	<i>Level 3 Tournament (32-41 teams)*</i>
1st	6 pts	8 pts	10 pts
2nd	5 pts	7 pts	9 pts
3rd	5 pts	7 pts	9 pts
4th	4 pts	6 pts	8 pts
5th	4 pts	6 pts	8 pts
6th	3 pts	5pts	7 pts
7th	3 pts	5 pts	7 pts
8th	2 pts	4 pts	6 pts
9th	--	4 pts	6 pts
10th	--	3 pts	5 pts
11th	--	3 pts	5 pts
12th	--	2 pts	4 pts
13th	--	--	4pts
14th	--	--	3pts
15th	--	--	3pts
16th	--	--	2pts

Chart used by permission from the Engineering and Technology Eurriculum Team & Gary Stewardson (2012).

system used around the world for teams to qualify for the world championships. Because there are various methods, a formal research project should be conducted to investigate the successes of the various methods.

CONTINUATION OF EFFORTS

The Utah State University VEX Robotics Team wants to continue to see growth of the VEX Robotics in Utah and the Rocky Mountain region. The USUVRT will continue to assist in these efforts by:

- Overseeing the Design Academy
- Hosting the Utah and Mountain Region VEX Robotics Championship
- Supervising and assisting with VRCs in Utah and Idaho
- Presenting at international and national conferences
- Writing publications for international and national journals
- Hosting workshops for teachers in the region

- Conducting an Occupational and Task Analysis to identify the outcomes of student participation in VEX
- Creating an instrument to measure the self-efficacy of students participating in VEX
- Conducting a longitudinal study to measure the self-efficacy of VEX participants and the impact the VEX experiences have on retention and completion in STEM fields of study in college
- Research best practices for promoting local growth in VEX Robotics

ACKNOWLEDGEMENTS

Without the support of the following sponsors, the rapid growth of the VEX Robotics Competition in the Utah and Rocky Mountain region would not have been possible:

- Rocky Mountain NASA Space Grant Consortium
- The National Defense Education Program through Hill Air Force Base
- The College of Agriculture and Applied Sciences at Utah State University

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