A Clueless Coach's Companion to the Vex™ Robotics Competition (VRC)

Version 1.3

Prepared by Yolande Petersen, 2011

Table of Contents

Introduction

In recent years, student interest in competitive robotics has grown exponentially, and with it, the need for coaches and mentors. As a result, many first-timers are being asked to step up to the plate, often with little guidance. This guide is a response to the question, “Where should I start?” Whether you are an engineer, an educator, or a community member with a desire to be involved, your skills can be useful to a team. While building robots may be the core activity of a robotics team there is truth to the cliché, “It’s not about the robots, it’s about the students,” and the needs of the students can be many and varied.

If you are a first-time coach, realize that the job will be challenging but manageable if realistic goals are set. Aiming to produce a functioning robot that accomplishes one or 2 simple tasks is probably within your grasp, and you may be pleasantly surprised at what the team can accomplish.

Almost every bit of advice in this document comes from mistakes made. While every coach will make his/her own mistakes, it's my hope to spare you from some of the more obvious ones.

Special thanks to folks from the Vex Forum (vexforum.com), whose suggestions and encouragement are greatly appreciated, including Rick TYler, gstew, jgraber, Friendly Giant, elizteacher, Yoder, and AnotherRoboMom. I would also like to give ultimate acknowledgement to the Firm Foundation, on which all my robotics efforts stand.

Yolande, aka ManicMechanic

What Is VRC?

The Vex Robotics Competition (VRC) is a game which is played by robots built by students. The 2 main competitions (Middle School/High School and College) have slightly different rules, which can be downloaded at http://robotevents.com . Rules the correct game manual for the given year. The game animation video and one-page game summary are helpful in giving a quick visual overview without delving into too much detail. The manual, typically over 20 pages, may seem tedious, but its rules are carefully crafted to provide a fair and challenging game. If a rule is ambiguous, questions can be asked on the official or unofficial forum (both found at http://www.vexforum.com/forum.php), and clarification will be given.

To participate, a team must first register as a team, then sign up for competition events (see the section on "Registering for Events"). While being part of a team can be incredibly hard work, teams that resist the temptation to quit are seldom disappointed. There's a tremendous amount of learning to be had by competing and viewing the work of others. *ATTEND A TOURNAMENT IF YOU CAN, EVEN IF YOU ATTEND AS A SPECTATOR OR PLACE DEAD LAST.*

There are several components of VRC, and teams have the option to participate in only those parts that they have the time or desire for. In addition, many events do not include all the components. The awards list is included in the game manual, sometimes in appendices, and additional awards may be added throughout the season. The World Championship event typically includes every award. The main components include:

1. Tournament Play - This is the centerpiece of most tournaments and is included in almost every official competition. Alliances of 2 vs. 2 robots play matches, where each team accrues a win/loss/tie record, followed by elimination matches to determine a winning alliance and a finalist alliance. Most teams that attend an event participate in the tournament part of the event.
2. Judging – Most events award the Excellence award (given to the team displaying both excellent technical skill and team dynamic), which is a judged award. Other common judged awards include the Build, Amaze, Innovate, and Think awards, though judged awards vary from event to event, and some events only assign the Excellence award. The judging process is also highly variable – some events interview teams in a quiet room during an assigned time slot, others have roving interviews with teams at their pit tables, and some events have no formal interview at all, basing their judging on observations of teams on the field. Usually, only the largest competitions (like Nationals and Worlds) assign every award from the complete list of awards. An engineering notebook is required for some of the judged awards, and a research project is required for the Future award (not commonly given). To ascertain which awards will be given, check with the event coordinator.
3. Skills Challenges – Many events include the Robot Skills and Programming Skills challenges, which some teams feel are a "true test" of a robot's ability. The robot operates autonomously (for Programming Skills) or under driver control (for Robot

Skills) alone on the field, attempting to score as many points as possible in 60 seconds, without the interference or assistance of other teams.

4. Online Design Challenges - These challenges can be performed remotely, without attending an event, and include digital prototyping, game animation, website design, and more. Participation in an online challenge may also be a prerequisite for winning the Excellence award at Worlds (admittedly, a goal for only the highest level teams). Check for deadlines and dates of entry: http://forum.robotevents.com/design/ .

Essential Resources

What does it take to start a VRC team? The following is a conservative estimate of necessary resources for a reasonable experience.

People! (in theory)

- Students, highly motivated (a minimum of 1, but the more the merrier).
- A technical mentor. This could be a knowledgeable adult or student, or an adult or student who is committed to learning from the internet or other sources outside the team.
- A team administrator who registers the team, receives e-mail communication, and transmits information to the other team members.
- Chauffeurs (not to be confused with drivers) who transport students to events.

Money! (in theory)

- $925 immediate equipment costs ($850 Classroom Lab Kit with Cortex + $75 software)
- $75 registration fee (for first team, $25 for each additional team from the same site/organization)
- $75 per event (a typical cost, though some are less expensive)
- $100 - 400 + for miscellaneous "wish list" items

Time! (in theory)

- ~20 hours for a rookie team to learn to build, program, and troubleshoot a robot which drives and scores at the lowest level.
- 50+ hours for a rookie team to perform "respectably"

People! (the reality)

Some teams are student-driven and require little adult assistance, other than paying the bills ☺. These teams tend to have students with an aptitude for robotics, and possibly prior robotics or programming experience. Then, there are the rest of us, who require more formalized training. Students (and mentors) who have less exposure and/or aptitude may become easily discouraged without sufficient support.

The internet, particularly the Vex forum (vexforum.com) has an abundance of ideas and designs. One caution is that students without a good foundation in the basics will sometimes see an idea and attempt to build it without a good understanding of how it works. Often they lack the parts necessary to build what they see, which is a recipe for disaster. In general, it's good to start with simple designs and build them successfully, working up incrementally. For students who are not able to self-learn, an important job of a technical mentor is to evaluate the students' level, determine what they're capable of, and set before them realistic, yet challenging projects. Some may want to use a formal curriculum (see Appendix A, Curriculum Resources), while others may pick and choose a few strategic projects for students to build.

For some teams (especially younger teams), mentors are greatly needed in personnel or project management. Even high school teams where students are "almost adults" need some adult intervention to stay on task now and then. Some teams get along "too well", and others, not well enough. Admittedly, not all "work" done by the students is entirely productive or goal-directed, and yet, it can contribute to the learning process (or just make life more fun). When you find a balance that's right for your team, you need not be intimidated by other teams that seem to operate more efficiently.

On some teams, the students are old enough to chauffeur themselves to events. Caution should be used if the events are far enough away to require an early rising. All-nighter + 5 am rising + 3 hour road trip in the dark and fog + 10 hours of adrenaline-laced competition + another 3 hour drive in the dark = road hazard. Sometimes, parents who are unable to attend for a whole day event may be willing to drop off students and "tag team" with another parent who is able to pick them up at the end of the day.

Some teams are squirrel-handed… (my apologies, if you're not a Strongbad fan)

Money! (the reality)

There are less expensive starter bundles than the Classroom Lab Kit ($850), but trying to build a robot for competition with, say, the Dual Control Bundle with Cortex ($550) will prove frustratingly limited. At a minimum, batteries and a charger must be added for $78, and by the time a Booster Kit ($180) is added, the price approaches that of the Classroom Lab Kit for far less value. Students (and adults) will always find exciting things to add to the wish list, as Vex is continually coming out with new parts to spend your pennies on. The section, "Purchasing a Kit" has more advice on commonly used parts. It's not a bad idea to start conservatively at first. As the team gets a better idea of what to build, it will become clearer which parts are needed, and it's common for teams to add parts in mid-season.

Many teams like to participate in more than one event, adding to the costs, although some events cost significantly less than $75. Not even mentioned is the cost of travel to long-distance, multi-day events which often involves airfare, hotels, and overpriced food at exciting venues.

Time! (the reality)

Time spent is highly variable and depends greatly on the talent and commitment of the team, with talented students working more efficiently than average ones. Some teams spend 30+ hours/week over a period of months, and while unprepared teams might throw together a robot a few hours before an event and work on it between matches. Realistically, a rookie team will probably need to spend about 20 hours to build and program a robot that drives and 50+ hours to learn the skills needed to produce a robot capable of performing "respectably". Once the initial learning has taken place, the building process becomes more efficient, and some experienced teams have thrown together decent robots just a day or 2 in advance. Students who attend more than one event in a season often redesign the robot after each event, but find that each rebuild goes more quickly than the one before. Caution: beyond 2 builders, the efficiency of a team is inversely proportional to the number of people working on the robot, unless your robot can be built in different modules.

Attending competition events also takes time. Some teams participate in only one event (or none), while others attend 10 or more events. Most local events last a full day, beginning with robot inspection in the morning, and ending with the closing ceremonies in the late afternoon or early evening. Championship events may extend over 2 or 3 days.

Team Logistics

<u>Team Structure/Affiliation</u>

VRC's requirements for a team are relatively flexible (10 students or less per team, no limits on mentors), and teams tend to fall into a number of categories, including those listed below.

1. School: Classroom-based - The robotics team(s) meet formally as a class, and the teacher takes on the primary mentor role, although parents may be enlisted to assist with special events. Costs are generally covered by the school's budget.
2. School: Extracurricular - Students meet after school as a club. Funding generally comes through the school's activities budget, or through private donations and sponsorship.
3. Community/Organization-based - The team may be part of an existing organization, such as Scouts or Boys and Girls Clubs, or it may be part of an organization that is dedicated to robotics. Funding may come from a number of sources, including the organization, contributions from the participants, and donations from local businesses and sponsors.
4. Home-based - The team is comprised of one or more interested students and is funded by the participating families and/or any sponsors they can find.

What team structure you choose will depend largely on the resources available and the needs of the students. If more than 10 students participate, extra teams may be added, but each team must have its own robot.

Classroom-based teams may require less monetary expenditure and assistance from the parents than the other types (though parental support in time and money will greatly enhance the quality of the team). They are, however, subject to the ebb and flow of the school budget, and a team without a strong commitment from the administration may find itself high-and-dry if a teacher retires or the school runs out of money. Also, school regulations regarding the transport of equipment and students off-campus vary from school to school, and can sometimes be prohibitive. An extracurricular team has a bit more flexibility, especially if it is funded by sources outside the school. If equipment is purchased with non-school funds, be sure to keep the receipts, to ensure that there is no question of ownership, allowing equipment to be transported off-campus. It is sometimes difficult for a school-based team to charge an "up-front fee", as access to all students, regardless of income is required by some schools.

School and community based teams tend to be larger than home-based teams, and they often have multiple teams meeting under the same roof. The greater number and diversity of students, as well as variety of ideas, can be an excellent breeding ground for learning. On the other hand, smaller, home-based teams tend to have greater scheduling flexibility. There are no limits to how long the robot can be worked on (other than fatigue), and fewer students generally means that each one has more freedom to complete and refine ideas before someone else takes the robot apart. There are some outstanding teams comprised of a single student.

Kit to Student Ratio

One kit for every ~4 students (or less) is ideal. While teams of 5 or more do manage with one kit, it's difficult in this situation for each member to participate in the building and the learning that comes with it. A greater number of students can be involved if the robot is built in modules (for example, separate chassis and lift), or if students are working on separate tasks and/or learning apart from the robot, such as programming using separate subassemblies, CAD, web design, photography, or updating the engineering notebook.

The most expensive part of the kit is the electrical system (see “Purchasing a Kit”), and teams that can’t afford 2 kits can maximize build time by stocking up on extra mechanical parts so that 2 robots or subassemblies can be built simultaneously, trading the microcontroller back and forth. Alternatively, it might be possible to obtain an old PIC system (microcontroller, RF receiver with chips, and RF transmitter) at a greatly reduced cost for a second kit.

Season of Participation

The Game Challenge for each year is usually announced at the World Championship event in late April or early May, and game objects are usually available for purchase at that time. While some teams begin to build and practice immediately for new game, many take off the summer and begin preparation when the school year begins. Fall events typically begin in late October and continue through March or even early April. A few events are held May – August, using either the old or new game.

Purchasing a Kit

VRC requires that robots be built exclusively from Vex™ parts or identical equivalent parts (for example, #32 rubber bands can be bought from most hardware or office supply stores). Parts can be purchased from their website: http://www.vexrobotics.com/products .

To build a competition-worthy robot requires a substantial investment. On the other hand, once purchased, these parts are reusable from year to year. Having a reasonable quantity and variety of parts allows students to try out a variety of designs, and once a design has been decided upon for competition, it's likely that a few task-specific or commonly used parts will need to be ordered mid-season. However, the following kits/parts are recommended as a start. Prices are rounded to the nearest dollar (as of 2011) and are subject to change.

Essential Items for Participation	**Part Number**	**Price**
1. Classroom Lab Kit	**P/N:** 276-1163	$850
2a. EasyC v4 for Cortex OR 2b. RobotC for Cortex and PIC	**P/N:** 276-1714 OR **P/N:** 276-1739	75
3. Segmented Angle 1 x 1 x 35	**P/N:** 275-1131	18
4. Angles 2 x 2 x 35	**P/N:** 275-1143	18
5. Game Object kit (different every year) Gateway for 2011	**P/N:**276-2102 (2011 only)	50
Total		$1,011

Recommended Items (in order of importance)		
1a. 2 X 2-pack 4" Omniwheels (4 wheels total)	**P/N:** 276-2185	$50
1b. High Strength Gear Kit	**P/N:** 276-2250	30
1c. High Strength Chain & Sprocket	**P/N:** 276-2252	40
OR replace items 1a, 1b, 1c with the Competition Robot Upgrade Kit, which contains these 3 items plus more advanced goodies		
1. Competition Robot Upgrade Kit	**P/N:** 275-1411	270
2. Vexnet Competition Switch	**P/N:** 276-2335	20
Total (for 1 and 2)		$290

The Classroom Lab Kit is a good value, and most teams will use enough of its parts to justify the cost. However, not every team will use all the parts in the Competition Robot Upgrade Kit at once. If you are trying to add parts gradually, the 4" Omniwheels, followed by High Strength Gear Kit, then High Strength Chain & Sprocket (in that order) are recommended. Teams advanced enough to use Linear Slides will probably use the other items as well and find it beneficial to purchase the Competition Robot Kit up front. The Vexnet Competition Switch is helpful for teams that want to trigger and test their autonomous programming, as well as simulate a competition match. Some older versions of EasyC v4 have autonomous triggering, but these are hard to find and not advisable for use, as using current software is important.

The extra angle bars (35 holes = 17 ½ in.) are recommended for building larger chasses, which tend to be more stable. The size fits within the 18" X 18" X 18" limit for robot size, though trimming or building short of the edges might be necessary if there are screws or parts that extend slightly beyond the boundaries.

The Game Object Kit ($50) contains sample scoring objects for the game of the year. While it doesn't provide a complete field, it is a cost-effective way for a low-budget team to build and practice with objects that meet official specifications. In order to have a full practice field, some teams also purchase the Field Perimeter ($800) and Field Tiles ($190) which are reused from year to year. You can substitute the Field Tiles with Softiles from a home improvement store at a lower cost. The Complete Competition Field Kit for each game (changed yearly) generally costs $400 - $500. Unlike the Game Object Kit which contains only a few of each scoring object, the complete kit contains an entire set of scoring objects (typically around 50) required to play the game. Be aware that it generally takes about an hour to assemble and another hour to disassemble the field perimeter and tiles, so many teams keep it together for a full season. While it is beneficial to have a full practice field, some teams do reasonably well by practicing with a few game objects and attending multiple events to get field practice.

Deciding how many and which extra parts to invest in depends to a large extent on the ability of the team members. If the team members are advanced and/or highly motivated, they are more likely to make good use of more complex parts. While lack of sufficient parts can create a vicious cycle (you don't buy the parts because you don't use them, and you never learn to use them because you don't have them), a team that masters the use of basic parts and creates reliable designs is better off than one with a huge inventory of parts that can't be used properly.

Used Kits

Vex™ kits sometimes show up on eBay, and depending on the price and condition, they can be a good deal. However, most used kits will contain the old PIC microcontroller (with crystal transmitter), which can't be used at many events. The major Championship events allow only Vexnet (used with the Cortex), but there are a few local events that will allow either crystals or Vexnet. In 2010, a number of significant upgrades occurred, including the microcontroller & transmitter, batteries, and motors, which makes used kits less valuable than before. While the old batteries and motors are permitted for use, they are less desirable than their newer counterparts. Used parts which are most useful are the sensors and non-electrical parts, including metal and plastic parts (like tank treads and gears). These may show signs of wear and tear, so purchase at your own risk.

Software Considerations

Software can be purchased on CD (item # 2 from Essential Items in the previous section), or purchased directly as a download from the following sites:

For EasyC V4: http://intelitekdownloads.com/easyCV4/
For RobotC : http://www.robotc.net/download/vex/

EasyC V4 has a 7-day free trial period, and RobotC has a 30-day trial period. After the trial period, you will need to purchase a license (for $75) which keeps the software activated. EasyC is uses drag-and-drop icons, which convert to text, and is recommended for beginners. RobotC is text-based and is recommended for intermediate to advanced programmers. However, there are advanced programmers who make effective use of EasyC as well.

If you purchase the CD, the version of software may already be outdated when it arrives. You should download the latest version from the above links – your license entitles you to download updated versions at no additional charge. New and improved versions are sometimes released every few months, or even every few weeks. This will affect you most significantly when you attend a tournament, as your software must be compatible with the tournament's version for your robot to operate properly. It's a good idea to communicate with the tournament coordinator about a week before an event regarding the version of software required to avoid unpleasant surprises.

Every time you download a new version of software to your computer, you should download the latest firmware (Master Code) on your microcontroller. Your microcontroller is then ready to be programmed.

Any programs you write for a Vex™ competition must be embedded within a Competition Template, which can also be downloaded from within the software (for both EasyC and Robot C, under the File menu > New > Competition Template). The template has 2 sections: Autonomous and Operator Control. Embedding your code within these sections allows the tournament controller to activate your robot for 20 seconds during autonomous, then for 2 minutes during operator control in synchrony with the other robots on the field. Since all robots are activated and deactivated simultaneously, no team receives an unfair advantage. All robots are tested for their Master Code version during robot inspection at the start of each tournament, and those without the latest version may fail inspection.

If you upgrade your software a few days before an event, you must update the Master Code on your microcontroller and create/save your program within the latest template. Rather than retyping your code, you can save your code segments as User Functions (in EasyC v4, right click User Function for options) in the old program. Create a new file using the new template and import these user functions into the new program (right click User Function and select "import"). Be sure to test your new program – sometimes code must be recalibrated with a new software version.

.

Registering for Tournaments

Team Registration

A team must be officially registered and obtain a team number before attempting to sign up for events. This can be done on the website http://robotevents.com -- select Vex™ Robotics Competition for Middle/High School (if that applies). VRC team registration costs $75 for the first team from a given site or school, $25 for each additional team. Unregistered teams cannot receive awards or advance to higher level events, so if there is a problem with your registration, you should contact tech support at support@robotevents.com.

Event Registration

Once you obtain a team number, you can view and register for the available events listed, also at http://robotevents.com . Local event prices vary, but commonly cost $75 or less per team. There are a few tournaments that require qualification/invitation (like Nationals and Worlds), but most events register teams on a first-come, first-served basis until capacity is reached. Events are continually being added throughout the season, so it's helpful to check back on a regular basis. To get a better idea of what events are likely to become available, check the list of events for the previous year, as schools and organizations often run annual events in a similar time frame. You might even contact the event coordinators, asking whether an event is planned for this year (and when), as many events are tentatively planned well in advance but not listed until the date is finalized. If you discover that an event you had hoped to attend is full, you may be able to be wait-listed if you contact the event coordinator. In particular, if this is your first season or if you are unable to register for other events in your area, the coordinator might be willing to accommodate your request.

The number of tournaments you attend is limited only by your budget, your calendar, and event availability. Many teams register for multiple events in order to accelerate learning and improve the odds of qualifying for Nationals or Worlds. Other teams prefer to spend their first tournament as spectators (most events are free to spectators), using the opportunity to observe and learn. Every time a team attends an event, it is exposed to new ideas and designs, and teams often redesign and improve their robots throughout the season. As a result, the level of play and scoring tends to be higher later in the season. The season culminates in the Vex™ Robotics World Championship, generally held in April or May.

The Game (you lose!)

Remember to download the complete game manual with all the rules at http://robotevents.com .

Student Roles

Building and Programming

Building a robot which performs the tasks necessary to score points in the game is the foundational task (you can't program a robot if it's not built). The robot also needs to be programmed to operate during the autonomous period, and also, to properly connect the appropriate motors to the joystick controls for the operator control period. Entire courses are taught on these 2 essential tasks, too much to include here (See Appendix A: Curriculum Resources).

Driving

Each team is permitted 2 student drivers on the field in any given match. Driving, a favorite job of fast-fingers joystick aficionados tends to be one of the more popular jobs, so some teams allow only the most committed, skilled, or senior members of the team to drive. Others rotate driving among members of the team for maximum exposure. The former usually produces a more skilled and consistent drive team, while the latter is a tool for keeping a greater number of students involved. Optimally, drivers should have a completed robot and access to field elements or a field well before the tournament to get used to the controls. Major changes like introducing new motors or reversing the direction of the controls should be avoided too close to tournament day, as even the best-designed robot will not score any points in operator-controlled mode unless driven properly. Mentors who are beyond high school age are not permitted to serve as drivers (in the HS competition).

Coaching

Adults or students may serve as the designated coach (one allowed in each match). The coach is not allowed to touch the robot controls (which results in disqualification), but in some games, is permitted to touch field or scoring objects like gates or balls. It is the coach's responsibility to be familiar with the rules, to keep an eye on the field, and to direct the drivers to score strategically throughout the match.

Scouting

Scouting generally has 2 purposes. If your team is a good one and expects to rank in the top 8 - 15 (or ~ top 1/3 of teams), a representative of your team may become an alliance captain and will need to select 2 teams to be your alliance partners. If your team does not rank high enough for you to captain an alliance, you will want to market the assets of your team to the higher ranking teams so that alliance captains will realize what a great pick you are! If you placed low in the rankings, but your robot has certain unique capabilities, you will especially want to target those teams that would benefit most from these abilities. More on alliances will be discussed in the "Tournament Day" section.

Technical Writing & Website Design

While an engineering notebook is not a requirement for participation, it is an essential component for many of the judged awards. Documenting the team's progress tends to be one of the less popular jobs, but it contributes greatly to the learning process, and if possible, everyone should participate. It is helpful to have a paper copy to give to the judges at tournaments, even if the notebook is recorded electronically. Often students who are not eager to write or sketch are willing to act as photographers, captioning significant developments. At the end of the season, the notebook becomes treasured memorabilia, and if saved in electronic form, can be distributed to each member. Having it makes disassembling the robot less painful, and if the notebook was done properly, the robot can be reconstructed at a later time. One suggestion which brings some closure to the season is to have each of the students write a summary of what they've learned throughout the season. The 2 sensible times to prepare these reflections are immediately before a tournament and immediately after the final event, and each has its own advantages. Writing the summaries before a tournament helps the students to reflect on the season and is good preparation for the team interview; it also gives the judges a fuller picture of your team's "journey." However, writing reflections after the tournament provides a true reflection of the season in its entirety.

Web documentation and videos are also common ways of recording your team's progress, and these are eligible to enter in Vex's annual Online Challenges. These challenges are announced via e-mails to registered teams, or can be found at the Online Challenge link here: http://forum.robotevents.com/design/. In the past, the challenges have been announced in the late fall (Oct. or Nov.), with the deadline for submission around Feb. or March.

Marketing

Two aspects of marketing involve 1) fundraising and awareness-raising in your local community and 2) making yourself known to other teams. As you become acquainted with other teams in the Vex community (both locally and online), the sharing of resources and information will greatly enhance your experience. Making T-shirts, brochures, and items for distribution to other teams on tournament day (like buttons or fliers) contributes to the fun and promotes interaction between teams.

Captain

The team captain is a student leader and frequently, a spokesperson for the team. Ideally, s/he has interpersonal skills and the respect and trust of all the team members. A captain should have a reasonable understanding the technical aspects of the robot, but is not necessarily the most advanced member technically – in a crisis situation, you want your best builder/programmer working on the robot, not settling personnel disputes. There are many teams that thrive without a captain, but in a situation where the usual adult coach or technical mentor is absent and a non-technical team parent is responsible for the team, it is helpful to have a technically knowledgeable student as a designated decision maker if the rest of the team is at an impasse, to avoid putting the non-technical parent on the spot.

Diverse Populations

Robotics is a natural fit for students who already have a demonstrated love of mechanical things and/or computer programming, and whose parents cultivate these interests. However, many robotics educational programs (and educators) have a vision to extend STEM (Science, Technology, Engineering, & Math) opportunities beyond populations where it has been historically successful. It may take effort to reach out to these populations, but the effort is usually worth it.

<u>Mixed-Gender Teams</u>

Having coached all-guy robotics teams for 4 seasons and mixed gender teams for 4, I feel that having a mixed gender team is something desirable when possible. With the addition of girls came new ideas and approaches, and I would like to think that each gender assists the other in being their "better selves." With girls around, our guys became less crude, more creative, and more hygienic, while the guys in turn brought focus and a sense of direction that were lacking when they were absent. Admittedly, there are certain risks that come with mixed-gender teams, including the complications of pairing off. However, if guidelines for appropriate behavior are given and enforced (e.g., no PDA at team meetings, making deliberate efforts to include other team members), these problems can hopefully be minimized.

While having both genders is desirable, my belief is that it should not be a precondition for having a team. Opportunity is more important that parity, and both genders are better served when a team aims to recruit students with a genuine interest and willingness to work, regardless of gender. There are many outstanding single-gender teams who feel this arrangement is optimal for their situation.

Some teams seem to draw girls into robotics effortlessly, while others struggle to get a single girl on board. Recruiting success is somewhat dependent on the environment, including girls' previous involvement with robotics or other STEM activities, the educational level and encouragement of the parents, or the culture and resources available in the surrounding community. However, there are things that a team can do to improve recruiting success.

1. Look for girls in science-based environments. In addition to "natural habits" for robotics, such as physics, computer, and AP math classes, try chemistry, biology, and art classes (for computer graphics-types). Extracurriculars like Science Bowl, Science Olympiad, and Academic Decathlon may also prove fertile grounds. Caution: If you raid a club for your robotics team, respond in kind by taking time off from robotics during their prep season, and send additional robotics members back in their direction, if their programs need additional participants.
2. Encourage girls to bring their friends, even if they're not "science-types". Girls tend to come in bunches, and sometimes non-science friends will discover an interest they never knew they had. Or they may enjoy certain aspects of the club, such as web design or documentation, enough to keep coming back.

Multilingual Teams

Robotics can be a great leveler, with C being the common language. Most teams, even those with second-language learners, will probably have students with sufficient English skills to effectively communicate during build time.

However, one time when otherwise hidden language issues may emerge is in the heat of competition, when rapid communication between drivers and coach is essential. Depending on the temperaments and language skills of the students, unilingual drive teams may be desirable. Alternatively, quick-thinking, linguistically talented students with may want to learn a few attention-getting phrases in their teammates' native languages to snap them into action if they "freeze".

Another time when language becomes important is when the team is interviewed, either for awards or press coverage. Often, the more articulate, verbal students will dominate, while their less verbal teammates are left in the shadows. Before any interview, it’s helpful to discuss with the students how credit will be shared. For those students who are less verbal, it might be helpful to have them rehearse what they will say, and have the leader-types practice how they will draw out their teammates and guide the course of the interview.

Students with Autism

Recent studies now estimate that 1-3% of all children are on the autism spectrum. While the exact connection between engineering and autism is not fully known, studies have shown that autism is about 2 ½ times more prevalent in children of engineers than the general population. If you work with large numbers of robotics students, chances are reasonable that one or more will be autistic. If you have a student who is diagnosed and introduced to you as autistic, it's helpful to gather as much information as possible from parents teachers ahead of time, to find out what problematic situations are likely to arise, and how to best deal with them. Find out whether confidentiality is required – if a student is having obvious difficulties, informing the other students and enlisting their help can encourage empathy and compassion. However, the autism spectrum covers such a wide range that it's possible that you may encounter students who are so high-functioning that they have never received a formal diagnosis. In the "old days", many people who today would be diagnosed with autism were merely thought "introverted" or "quirky."

There are certain times when autism may actually be advantageous, as some autistic students have an unwavering dedication to completing a task, and obliviousness to outside distractions. If so, enjoy it for all it’s worth!

While each case is unique and will be handled differently, one universal principle is that nothing succeeds like success. When a student has significant achievements and becomes a needed part of the team, his/her sense of well-being and respect from teammates is likely to moderate any negative effects. Helping all students (including autistic ones) to find their area of success should be top priority.

The Elephant In the Room

One issue that is likely to emerge with diverse teams is that some opportunities in engineering are available to certain targeted populations (most commonly women, underrepresented minorities, and economically disadvantaged students) that are not available to others. This sometimes creates tension that can have a negative impact on a team.

I have found these concerns easier to deal with on an individual basis than in a group setting, as it's easier to address an individual's unique complaints without other students' commentary fanning the flames. While the concerns are real and often reasonable, more progress can be made when students see what they have, rather than what they don't. In one case, I pointed to the unique opportunities that a disgruntled student had (connections to jobs through his father's personal contacts and place of employment), emphasizing that not everyone gets the same opportunity, but each is responsible for using the opportunities they encounter to their best ability. Also addressed was the source of opportunity: one student had received a scholarship from an ethnic organization, funded by private donations, and it was agreed that donors should have the freedom to donate to causes/people of their own choosing. Another point was that sometimes non-targeted students are actually beneficiaries of their teammates' fortune – two lower-income students on our team had received some funding, allowing them to attend Worlds, and they contributed their "team share" of the registration fee and upgrade parts. Had they not attended, fewer students on the team would have meant a larger share of the cost for each of the remaining students.

It is a strange thing to hear a student wistfully exclaim, "Lucky you!" in hearing of a teammate's low-income lunch status. But it is a blessing to see the same student mature and remark years later, "I can see that both my situation and yours has its own advantages and disadvantages, and we can both find some good opportunities for our futures." Our students will always be surrounded by others who have more and less than they do, and we do them a service when we can help them find contentment in what they have.

Tournament Day

The Week Before

1. Work through the Robot Inspection Checklist, found in the Game Manual. Fix any issues that don't meet specifications, so you won't have to fix them on the day of.
2. Check for any communications from the tournament coordinator. Verify that you have the latest version of Master Code.
3. Finalize carpool arrangements.
4. Charge batteries. Remember to pack the charger(s).

Tourney Day Checklist

Robot (with team # and other requirements met)
Transmitter/Joystick
Fully charged batteries (and spares, if you have them)
Battery chargers (both kinds if needed)
Laptop with your programs
Extension cord and power strip with enough sockets for all battery chargers and laptop
Robot kit with spare parts
Tools
Safety goggles/glasses
Engineering notebook
Supplies like tape, Sharpie markers, pens, scissors, Ziploc bags for emergencies
Give-away items, like buttons or handouts
Snacks (if allowed)
Money for food (if sold on site)
A desire to have a great time!

Arrival

When you first arrive, you will need to check-in, drop your supplies at your pit table, and have your robot inspected. Robot inspection is a thorough process and may take up to ½ hour, depending on how diligent you were in complying with the regulations. In addition to meeting size and materials specifications, you must have the correct version of the software and competition template loaded onto your microprocessor.

Preliminary activities

Once your robot is inspected, if there is time, you may have the opportunity to participate in practice matches before the opening ceremonies. Some events have a practice field where teams can practice informally. Once all the teams have checked in, a match schedule will be issued. Look for and highlight/circle your team number and the numbers of the matches that you will play. Some teams like to touch base with their alliance partners to strategize for maximum cooperation and scoring.

Some tournaments conduct interviews before tournament matches begin, while others intersperse them informally throughout the day. If Skills Challenges are offered, you may want to see how these will fit into your scheduled matches, as many tournaments offer the Skills Challenges as an optional activity which teams must take the initiative to sign up for individually.

Qualifying Matches

Once the opening ceremonies are complete, formal matches which "count" will begin. Each match, you will be randomly assigned to an alliance (either blue or red), and your robot should include a flag holder that allows you to place colored flag in place. Tournaments often run behind schedule, but the match number is a good indicator of time before your next match (matches typically run 3 – 6 minutes apart, depending on your event's set-up). About 5 minutes before each match, it's a good idea check your batteries and test each motor for proper functioning. Before the match begins, you will need to plug your joystick into the field tower, turn on the robot, turn on the joystick, then check for linking. If you are using a PIC controller and transmitter, you will need to obtain competition crystals (one for the transmitter, one for the microcontroller).

Alliance Selection

Alliance selection is a fascinating process but can be a bit overwhelming the first time around and deserves some fleshing out. Precise detail on the rules governing the process are given in the VRC Game Manual.

One representative from each of the 8 top-ranked teams (or fewer for small tournaments) will have the opportunity to become an alliance captain. At least one representative from your team should attend the Alliance Selection, even if you do not think that you are likely to be selected by an alliance – surprises do happen, and you may unexpectedly find yourself in the position of becoming an alliance captain. If your team is invited to be on an alliance, you will want to have someone there to accept the invitation.

The process begins when the #1 ranked team invites a team to be its partner. It may select any team with a lower rank, including other teams that are ranked in the top 8. Suppose that #1 invites #2, and #2 accepts. Then, #2 is no longer an alliance captain, the #3 team becomes the captain of the second seed, and all the teams move up a slot, with the #9 team becoming a captain to fill the spot vacated by #8. This process continues until 8 captains have chosen 8 partners. In this way, it is possible that a team ranked as low as #15 could become an alliance captain. Once each alliance has 2 teams, each alliance, in order of ranking selects a third team.

In general, most teams accept an invitation, because once an invitation is declined, the team cannot be invited by another team. The 2 main reasons why a team would decline are 1) their robot is malfunctioning and as gracious professionals, the team does not want to jeopardize the alliance's performance or 2) they plan to captain their own alliance, which is allowable if they rank high enough to serve as a captain.

If you do captain an alliance, realize that another alliance may select your desired choices before you, so it's helpful to have some idea of the abilities of many of the teams. While some captains simply select the highest-ranking available team, a more strategic approach is to choose teams that will best complement your robot's abilities. In addition, some very capable robots have a mediocre or low rank because they were paired with low-scoring partners during the qualifying matches. The best way to judge a team is to have scouts carefully watching and evaluating the performance of every robot during qualifying matches. Scouts often prepare a summary sheet with a checklist of abilities for each team's robot.

Elimination Matches

In order to move up the ladder, an alliance must win 2 of 3 matches. The game is still played 2 teams vs. 2 teams, with one team from each alliance sitting out each match. It is mandatory that all 3 teams in an alliance play at least once in the first 2 matches, so that if the alliance is eliminated by losing 2 in a row, each team will have had the chance to be on the field at least once. Through elimination, 8 alliances are winnowed to 4, then 2. The undefeated alliance then becomes the Tournament Champion, and the 2nd place team earns the Finalist Alliance award.

Closing Ceremonies

Once the final matches have been held, the Tournament Champion, Finalist Alliance, and judged awards will be handed out in an awards ceremony. Remember to thank the volunteers and tournament organizers when the event is finished – they worked their tails off for you!

Appendix A: Curriculum Resources

Note: Most resources are written for the PIC microcontroller, not the Cortex, which was recently released.

Free Resources

1a. 2008 Vex Inventor's Guide - The official Vex manual with 2 step-by-step building projects: http://www.vexforum.com/wiki/index.php/Inventor%27s_Guide

1b. 2005 Vex Inventor's Guide – Programming Guide. The 2008 Inventor's Guide lacks this very helpful section on beginning programming: http://www.vexforum.com/wiki/index.php/Inventor%27s_Guide

1c. Vex Protobot and Tumblerbot build instructions - Step-by-step instructions for the Protobot (example robot that drives, grabs, and lifts), and the Tumblerbot http://content.vexrobotics.com/docs/Protobot-Quickstart-Guide-10112010.pdf

2a. Vex Machinations: A Step-by-Step Project guide – A builder's guide with 16 simple projects that progressively increase in complexity. It assumes that you have already worked through the 2005 Vex Inventor's Guide – Programming Guide above (item 1b). http://peterseny.faculty.mjc.edu/resources/machinations.pdf

2b. Vex for the Technically Challenged - A brief overview of mechanics and programming, which goes together with Vex Machinations: http://peterseny.faculty.mjc.edu/resources/technicallychallenged.pdf
If you have trouble downloading these resources, go to the main page http://peterseny.faculty.mjc.edu/robotics.html and right click on the links at the bottom of the page. As one of the authors, I have a "slight" bias towards these 2 resources. They have been "dummy tested" on more than 50 beginning students with reasonable success.

2c. Vext Steps (planned for release in Fall 2011) – A guide for lower intermediate users, intended to move builders to the next level in driving base and lift design. It should be posted on the Vex Wiki and my website: (http://peterseny.faculty.mjc.edu/robotics.html) when complete.

3. Competitive Vex Designer Curriculum by Trevor Robinson. This formal curriculum has formal lessons that progressively teach important engineering concepts. To use this curriculum, it is beneficial for students have some previous building experience, as there are no "Attach screw A to hole B"-type instructions. http://www.engr.usu.edu/ete/faculty/etct/robo/vex-da.htm

5. The Vex Wiki http://www.vexforum.com/wiki/index.php/Main_Page - This has information on many aspects of Vex robotics. The information is sometimes hard to find (click on icons, as well as text links), and the amount can be overwhelming at first. Some of the resources included:
   - Glossary with brief descriptions of acronyms and terms: http://www.vexforum.com/wiki/index.php/Terminology
   - Product descriptions and in-depth definitions of terms: Under "Technical", click icons for Motion, Structure, Power, etc.

- Additional curricula
- Team pages
- Links to additional sites
- And so much more! Check it out!

5. The Vex Forum - Ask nice questions, get good answers. If you ask questions in the unofficial sections, you will probably receive quicker answers, as there are far more "ordinary" users than staff members. http://www.vexforum.com/forum.php

Purchased Curriculum

The following curricula are highlighted on the Vex Wiki: (http://www.vexforum.com/wiki/index.php/Curriculum). Being a tightwad, I haven't purchased any of these resources and can't comment on their quality.

1. Autodesk Vex Curriculum - This is included in the Classroom Lab Kit, or can be purchased separately for $200 from http://www.vexrobotics.com/276-1263.html . The CAD part (Computer Aided Design) requires separate purchase of Autodesk Inventor (software), but it is possible to skip the CAD sections.
2. Intelitek's Robotics Engineering Curriculum – http://www.intelitekdownloads.com/REC/
3. Robotics Academy at Carnegie Mellon – http://www.education.rec.ri.cmu.edu/