AC 2011-1022: THE MATE INTERNATIONAL ROV COMPETITION A UNIVERSITY PERSPECTIVE

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The MATE International ROV Competition – A University Perspective

Abstract

The MATE International ROV Competition provides college, high school and middle school students with an exciting hands-on educational experience. College and university students live in a different world than their high school counterparts, however, and their advising needs are substantially different. Time management in particular is an important issue with undergraduate engineering students who have heavy course loads with little free time. Advisors and departments supporting university-based ROV teams must be aware of these needs and actively work with the students to help them get the maximal educational benefits from their participation in the ROV Competition. This paper discusses the dynamics of a university-based ROV team and the changing role that the advisor must play as the team evolves in time. These issues are discussed in the context of lessons learned from the author's experience as the advisor of the University of Wisconsin-Milwaukee ROV Team.

Introduction

The MATE International ROV Competition provides a unique hands-on experience for engineering undergraduates that engages them on many levels. As with all build it – type competitions it offers students a chance to connect theory to practice in an exciting way. Because of the highly multidisciplinary nature of ROVs, team members learn how to modulate their designs based on considerations outside of their major fields in order to optimize the whole system. This requires the students to become literate in other areas of engineering so they can effectively interact with their colleagues in the team, thus preparing them for real-world careers where team efforts are the norm. The ROV competition plays yet another important role in exposing students to ocean and marine engineering careers. In order to best realize these and other benefits it is important that the students be given the proper advice and oversight by the ROV team's faculty advisor. College students live in a different world than high school or middle school students and their advising needs are substantially different. Time management in particular is an important issue with undergraduate engineers (who constitute the bulk of college-level ROV team members) who have heavy course loads with little free time. Advisors and departments supporting university-based ROV teams must be aware of these needs and actively work with the students to help them get the maximal educational benefits from their participation in the ROV Competition as well as to have it be a positive and inspiring experience.

This paper is based on the author's experience as the advisor to the University of Wisconsin – Milwaukee (UWM) ROV team. An ROV team can be considered to exist in one of three phases: 1) the start-up phase when the first generation of students is established, 2) the sustaining phase during which more experienced students recruit and train new students who will carry on the team as the older students graduate, and 3) the dissolution phase when pipeline of new students dries-up and team becomes reduced to a dysfunctional level. These three phases will be used to organize the following discussion of student and team dynamics and the evolving role of the advisor.

ROV team formation

The start-up phase is the founding of the team. Here the advisor must play a very active role in recruiting students. The overall goal is to develop a cadre of dedicated students who will take over as the active leaders of the team. There are two primary areas that the advisor needs to address: 1) introducing the concept of ROVs, their applications and the engineering challenges in building such vehicles, and 2) teaching students how to work effectively as a group in a project that is outside of the structured classroom environment.

At the very first meeting of the nascent team the advisor must, of course, give an introductory lecture on ROVs. This step has recently become much easier because of the live video feeds of ROVs working to cap the oil well during the summer 2010 oil disaster in the Gulf of Mexico. Simply talking about ROVs, however, is only the first step in the process of attracting students. Viewing workhorse ROVs can intimidate students, especially those who have not had much if any hands-on building experience. Rather than attracting students, the lecture may have the opposite effect and drive away students who feel that ROVs are beyond their grasp. An important second step is to guide the students through the process of building and operating a simple ROV. This was done at UWM with the Sea Perch ROV[1], a simple vehicle made of PVC pipe and toy motors and controlled by three switches. Sea Perch construction quickly established an easy to achieve baseline of technical knowledge and skill in the team members. The experience of operating the Sea Perch was perhaps the single most important step in exciting and motivating students to participate in the team. Lectures and images simply cannot convey the fun, fascination and challenge of actually flying an ROV in its three-dimensional aquatic world. The experience is made even more engaging because the little vehicles they are operating are ones that they made themselves. Simple ROVs like the Sea Perch bring-home three important points to the students: ROV technology is accessible, a working vehicle can be created with only three motors and switches; ROVs are fun, especially equipped with onboard cameras enabling fish-eye views underwater; and ROVs are open ended, after a few minutes of driving an ROV students begin to think about design changes to improve the vehicle's performance and give it new capabilities. The best advice to give the advisor of a new ROV team is to get the students building and operating simple vehicles as soon as possible.

Getting students to work on a project outside the classroom is a daunting task for an ROV team advisor. Too often students are in the position of passive spectators either in a lecture hall on the Internet. In these situations students often receive information without the need to either assess the quality of the information based on their knowledge and intuition from real-world experience, or decide on the importance of the information in the context of the task at hand. A good way to change this dynamic is to make the students "get off their chairs" and find out for themselves. For example a student may ask what happens if a 6V rated motor is powered at 12V. Rather than simply say the motor will run fast and burn out, it is much better to tell the student to try it and find out (of course use a cheap motor and observe proper safety procedures). By constantly repeating the mantra "try it and find out" and backing it up by making the necessary parts and test instruments available, the students will come to reflexively grab a multimeter, or a ruler and a stop watch, or whatever is necessary to get an answer. Such an instinct to observe and measure, rather than "Google" will prove invaluable to the students' performance in a lab-based courses as well as impress interviewers who may ask a candidate to solve a little problem on the spot.

Time is a precious commodity for college students, especially for those majoring in engineering with many difficult required courses. Time management is, therefore of paramount importance to members of a college-level ROV team. Time management is also, unfortunately, a struggle for most college students (hence the popularity of "all nighters") so learning and practicing good time management is one of the great benefits of ROV team participation. The first challenge is for the students to realistically plan their work on the vehicle, this is most difficult for new teams where few may have hands-on building experience let alone experience with ROVs. The advisor can help at this stage by encouraging the students to be realistic about the time they can devote to the project. Simply asking the questions “who is going to do this and when” in front of a large print-out of the semester calendar helps to force the students to bring their expectations in line with their available time resources. Indeed, the realization that time is a resource, every bit as important as tools, components and money, is an important and valuable lesson for the students to learn. Understanding time constraints also connects to the real-world technical realm where time becomes a major criterion with which accept or reject proposed designs.

A system of time management should be set-up to permit a student to come to the workshop whenever he/she has time, do some work, and then inform others what has been done so another student can later come in and pick-up where the previous person left-off. This “pipelining” of work is an effective way of coordinating a group of students with different schedules to accomplish a common task in a reasonable period of time. The Internet has made such a system easy to implement because students can simply post their progress on the team’s web page, wiki, or through group emails. This system also illustrates the important connection between time management and communications in group projects.

Time management is also inextricably linked to the individual and group psychology of the team. For example, a student volunteers to build an arm for the ROV and the team members are enthusiastic about the prospects of such an addition to their vehicle. Quickly, the student learns that robotic arms are quite difficult to construct, underwater arms even more so. The student feels that he is not capable of the task, and/or realizes that he has no time (papers due, exams, etc.). Feeling embarrassed the student stops attending team meetings and becomes incommunicado with his teammates. As time progresses a larger and larger fraction of the team’s precious meeting time becomes devoted to discussing the arm and the student – often resentment builds in this situation threatening team camaraderie and cohesion. The author has seen this scenario play-out several times in the ROV team and in other group engineering projects so it is important for the team advisor to identify when such a situation is occurring and take steps to fix the problem. Perhaps the best way to avoid this problem is to explicitly discuss it at the start of the team. The aforementioned scenario can be presented with an ensuing discussion on how to deal with it in a way that keeps the team moving forward and preserves the esprit de corps. The author suggests bringing up the following points to the students:

1. Avoid over commitment by realistically assessing your available time for the project.
2. Don't agree to do something at the same meeting in which you have a "great" idea. Take some time to research the idea or device and fully understand the scope of the project. You may realize that it is better to do the work in collaboration with other team members instead of going solo.
3. Upon encountering problems immediately bring them to the attention of your teammates at the next meeting. This will allow the team to decide to either put more resources (people) into the project or to abandon it. The earlier these critical decisions are made the higher the chances for success (i.e. a working ROV at competition time).
4. It's OK and even desirable to be wrong – that is part of the design process and how you learn. Knowing that your idea won't work (for whatever reason) is valuable information – it prevents the you and your team from going down wasteful dead ends.
5. NEVER stop communicating with your teammates.

Two more essential activities that must be initiated by the advisor are brainstorming sessions about the MATE ROV challenge, and mini-tutorials on technical subjects that are of interest to the students and relevant to the development of their ROV. Brainstorming can be a fun and exciting activity but the challenge for the advisor is to get everyone to participate. The key here is to make sure all the students realize that their ideas (right or wrong) have merit and deserve to be presented and discussed. The author knows of a lab at MIT whose motto is "No Squashing." This means that it is OK to criticize an idea on technical merit but it is not OK to simply dismiss an idea (or its originator) in a derogatory way such as calling it stupid. It may be useful for the advisor to suggest a few faulty ideas and use the ensuing critical discussion as a way to show how civility and professionalism can keep meetings productive while not stifling creativity. Another point to bring across to the students is that simple ideas are often the best ideas. Again this reinforces the notion that everyone who has an interest ROVs has something to contribute that is worthy of group discussion. This is a good way of showing the students how much they already have within themselves (experience and common sense) regardless of their level of formal education and it is also great confidence builder.

To a very practical end, the advisor should give, or bring in people to give, mini-tutorials on topics that will help the students develop their ROV. This author has given tutorials on electronic constructions techniques and microcontrollers. The latter topic is especially interesting to team members because engineering students typically don't get exposure to microcontrollers until late in their curriculum. Simple yet capable microcontroller boards that can be easily mastered by beginners are readily available such as the Basic Stamp (Parallax Inc., Rocklin, CA) and the Arduino (www.arduino.cc). Microcontrollers form a good context to introduce a lot of electronic concepts to students such as sensors, amplifiers, digital logic circuits and communications, in addition to programming. Last but not least the advisor must have a discussion with the students about safety both in the lab and in the field.

Sustaining an ROV team

Once a team has been successfully established it then evolves into the sustaining phase. Now the advisor largely moves to the background and supplies advice and help as needed by the team's participants. The sustaining phase is essentially the goal of an ROV team advisor. Ideally the team will be composed of students at several levels (freshmen to seniors) so there will be a steady turnover of students with the new ones being trained by the more advanced members. The advisor should always take an active hand in maintaining the tone of the team (see "no squashing" above) and in monitoring its activity. Safety education should also be a duty of the advisor.

As more experienced students takeover team leadership they will also become the mentors of the new members. Here the advisor has the opportunity to discuss teaching and mentoring to the team leaders thus giving them valuable skills in project management and perhaps inspiring few to pursue teaching careers. Finally, the advisor should make sure that the team maintains a diversity of students and does not become a closed circle of friends of the team leaders. This can be accomplished by insisting that open recruitment drives occur every year or semester.

When an ROV team fails

Sometimes the pipeline of students dries-up and a team become reduced to the point of being dysfunctional, this is the dissolution phase. In this situation the advisor must step in and take an active role in rejuvenating the team. The advisor must have a serious talk with the remaining students who probably have competed in several ROV competitions and may feel an obligation to keep the team going even though their hearts are no longer into it. First they need to be reminded that the ROV team is meant to be a fun and educational activity. If it has become a chore to the student then he/she must seriously consider bowing out of the team and moving on to something else. Even if the students enjoy the team the advisor should point-out that they may have gotten all they could get out of their participation. Such students may find a background role in recruiting and mentoring new students a more satisfying experience than active team participation.

In many ways, a team in the dissolution phase has devolved back to its formative phase and recruiting and training must come back to center stage. Team recreation is made easier if there is a cadre of senior students (mentioned above) whose focus is recruiting and training. Another invaluable resource are team alumni, usually graduates who live in the area. Alumni can serve as co-advisors to the team; keeping an eye on progress when the advisor is away. Recent alumni are much closer to the ROV team members in age and, therefore, can be more effective in giving advice than the "old man" (the faculty advisor). They can serve as role models for the team and discuss other issues of importance to the students such as how to find a job and what's it's like to work for a company. These ancillary conversations are an unsung but important educational aspect of ROV teams. The author has found in an earlier Sea Perch-focused program[2] that the students spent a lot of time talking about school and other topics while painting their vehicles. The social interaction of students united around a common goal like building ROVs should always be encouraged. It dispels anxiety, gives a sense of belonging and helps the students develop an inner sense of self that will help them survive and thrive in a competitive world.

Conclusions

The advisor of a university-based ROV team must be an active player in the team's formation, maintenance and in reviving the team from a slump. Time management, communications and student psychology all interact and must be monitored by the advisor to insure that the students are benefitting intellectually and socially from their ROV team participation. Early establishment of a good team operating environment is the best way to accomplish this goal.

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