

# Inter-Institutional Student Developed Team Based Project

Harry Hubbert<sup>1</sup>, Isak Bowden-Floyd<sup>2</sup>, Alexander L. Forrest<sup>3</sup>, Mark Symes<sup>4</sup>  
*Australian Maritime College a Specialist institution of The University of Tasmania,*  
*Corresponding Author Email: [ifbowden@utas.edu.au](mailto:ifbowden@utas.edu.au)*

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## CONTEXT

Team based inter-disciplinary projects provide an integral component in the development of graduate attributes for engineering students. These attributes can be refined and advanced through the development of an inter-institutional student competition led by students. Students and people in general, are more willing to learn when we are motivated. The positive effects of motivation, combined with the necessity of team work in an engineering team based competition, is an ideal method of inspiring, motivating and advancing the professional skills of engineering students. In this work, we propose that the Australasian Autonomous Underwater Vehicle (A<sup>2</sup>UV) Competition, created by the Australian Maritime College Autonomous Technology (AMCAT) student-led society, will provide students from all tiers of tertiary education, from undergraduate to postgraduate levels, with invaluable, practical and professional skills, whereby gaining experience for their future careers.

## GOAL

Engineering education pedagogy can be developed through the formation of inter-institutional student based competitions. The outcomes aimed to be achieved from the development of these competitions include: (1) the growth of a student's professional skills, research practice and design processing; and, (2) the successful coordination of a major undergraduate engineering challenge. A combination of team competitions, group projects and regular project meetings aim to provide a platform that allows the effectiveness of the project to be analysed relative to the student learning and development.

## APPROACH

The proposed approach to the development of the competition was initialized first by the creation of student-led society focused on the development of autonomous technologies. Following the establishment and development of this society, a need for an inter-institutional based competition was identified. This society has then reached out to other schools within Australia to develop this program.

## ANTICIPATED OUTCOMES

The anticipated outcomes to be achieved from this competition based project are inter-institutional networking and collaboration, work integrated learning and the development of essential professional skills in students. A team-based, hands-on learning environment provides an interactive experience whilst engaging and motivating students to learn and teach each other in a problem based learning situation. All the while, the students are developing the necessary graduate attributes and professional skills required for future workplace applications.

## CONCLUSIONS

The formation of the nationally interactive student based competition, the A<sup>2</sup>UV Competition, establishes an inter-institutional educational relationship. This relationship gives students the opportunity to further expand their passion for the field of underwater and autonomous technologies.

## KEYWORDS

Engineering, Student, Inter-Institutional, Learning, Autonomous Underwater Vehicles

# INTRODUCTION

The Australian Maritime College (AMC), a specialist institute of the University of Tasmania, provides a specialized learning environment for engineering students to further their abilities and skills. This is done by engaging in new activities and pursuing interaction with new experiences within the maritime engineering field. This desire to learn and strengthen skills has been recognised as a significant benefit to students as industry feedback has emphasized these attributes are valuable in graduates. The design and development of an inter-institutional, student-based competition will provide students with opportunities that will be beneficial to the foundation of attributes representative of a professional graduate engineer such as: (1) the management of self and others; (2) solve maritime engineering problems; and, (3) design for the marine environment (M.Symes, 2013).

The field of engineering has experienced a steady growth in competitions including the SAUC-E (Curtin, 2011), RobotX (Davidson, 2013) and Robo-Sub (AUVSI, 2013), competitions all primarily focused on the development and construction of AUVs. The majority of these competitions are based internationally with very few including participation from Australian teams, showing that Australia is falling behind in this game in this field. In early 2013, the Australian Maritime College Autonomous Technology (AMCAT) Society proposed the development of the A<sup>2</sup>UV competition (J. Keane, 2013). The A<sup>2</sup>UV competition is designed to merge the development of student built autonomous vehicles whilst integrating project management experience associated with forming and maintaining a team of students. Specifically members will develop transferable skills and be involved with the successful coordination of an advanced team engineering project, while meeting the goals of the society.

Goals of the society include (AMCAT, 2013):

1. The Australian Maritime College Autonomous Technology Society aims to bring together people with a collected interest in Autonomous Maritime technology and provide support, research and developments in this field of engineering.
2. AMCAT will create opportunities for undergraduates to plan and execute projects for nationwide and international competitions and other applications emphasizing interdisciplinary cooperation for innovation.

Accomplishment of these will be done through utilizing the focused drive and energy within a structured and organised group of proactive students. The annual continuation and expansion of competitions such as Robo-Sub provides evidence supporting the significance of student driven projects and their importance within engineering education.

The A<sup>2</sup>UV Competition has been identified as a project possessing characteristics that are relatively hard to quantify. It has been proposed that future research will be undertaken to measure the success of this project by using quantifiable metrics developed using a combination of social media and publically available networking programs, using the following objectives for comparison:

1. Expansion of AMCAT through social media to increase member involvement in the A<sup>2</sup>UV competition development;
2. Networking with academic institutions, industry partners and societies;
3. Development and awareness of the A<sup>2</sup>UV competition within this network; and,
4. Successful organisation and completion of the A<sup>2</sup>UV competition.

# THE COMPETITION

The objective of the student developed inter-institutional A<sup>2</sup>UV Competition is to encourage the formation of student driven societies through the inclusion of a competitive and structured project based learning task. The involvement of AMCAT, in addition to mentoring by staff and faculty at AMC, will provide valuable support in the development of the competition whilst demonstrating the capabilities, professionalism and dedication of the students involved. It is expected that the skills attained by students through the progression and development of this competition will build key attributes that are characteristics of a successful undergraduate engineer (AMC, 2013). The aspects of the competition's development and progression described in this work only includes currently available results and information that encapsulate the development stage of the competition as the proposed event is not scheduled to run until mid-2014. This paper describes the development and implementation of a student developed society. We attempt to show how such a society can lead to students developing the necessary skills and attributes and a desire to pursue lifelong learning.

## BACKGROUND

Problem based learning has been increasingly recognised in the education community as being a crucial element in the development of the ability of engineering students to perform strongly when placed in a work environment (Woods, 1996). Learning performance has been well scrutinised in recent years, with intentions being to attain an understanding of the way students achieve and learn (Katsioloudis, 2012). It has been identified that when learning outcomes have been linked with direct application there has been a significant improvement in the accomplished learning achieved especially by adults (Adeel Khalid, 2013). The integration of student based projects as a fundamental part of learning exposes a strong support network; further increasing the ability of students to become directly involved in the research and development aspect of the university (Popov, 2003). This furthers the supporting evidence and highlights the potential benefits able to be achieved by the implementation and development of student run project based learning tasks.

The inherent ramifications from the development of an Australia wide inter-institutional competition include the growth and expansion of domestic networks, relationships and contacts within the maritime engineering division; including academic, research and industry based entities. Such exposure provides opportunities and avenues for not only the AMCAT Society but any individual members involved with the project.

## DESIGN

The A<sup>2</sup>UV Competition aims to develop and significantly improve the learning opportunities for the AMCAT Society members. The design and development of the competition is focused around four key elements. These elements, as summarised in the introduction, are:

1. Expansion of AMCAT through social media to increase member involvement in the A<sup>2</sup>UV competition development;
2. Networking with academic institutions, industry partners and societies;
3. Development and awareness of the A<sup>2</sup>UV competition within this network; and,
4. Successful organisation and completion of the A<sup>2</sup>UV competition.

The expansion and progression of communication through social media has been recognised as a cost effective and efficient method of information sharing, project groups construction and team organisation (Baruah, 2012). This has identified as being strong tool that will be able to be used in the development and running of the A<sup>2</sup>UV competition. The construction of a Facebook account has allowed members easy access to the meeting minutes, times and progress updates as well as upcoming events and important milestones. The utilisation of an online project management site has allowed for all members to keep up-to-date on the

development of not only the competition but all other projects and construction progression within the society.

The initial forms of networking deemed as being important to the development of the A<sup>2</sup>UV competition were the universities willing to partake in the competition. The academic institutions identified included: University of Western Australia, University of Sydney, University of Adelaide, Flinders University and University of NSW. All of these universities have been involved either in the field of underwater technology, the research and development of AUV technologies or the development of marine based robotics. Communication was commenced primarily via email in order to achieve an understanding of enthusiasm, followed by further communications between students and mentors between institutions. The competition rules originally produced by AMCAT were forwarded to all prospective competitors in order for feedback to be obtained.

The development of A<sup>2</sup>UV competition and recognition within the engineering community and maritime industry is an aspect that has been recognised as being important in the networking and support process of both the society and competition. The ability to identify this competition as a credible and innovative project within the engineering education community provides the A<sup>2</sup>UV, including the AMCAT Society, the opportunity to progressively grow, beginning to incorporate sponsors, prizes and more comprehensive tasks. In essence this aspect of the competition aims to allow for expansion, including the inclusion of a greater scope of competitors, task and partnerships with each consecutive competition. The compilation of pre and post competition newsletters and advertising will aid in the competitions general awareness in the community.

The overall accomplishment of the competition relies on the comprehensive design and planning carried out prior to event, beginning with finalisation of competition documentation: rules, vehicle specifications, course design and mission plans. The circulated competition overview included the complete course rules, design specifications of the AUV, event details and project limitations. The primary competition design included:

1. Design a course that engaged the competitors, not specifically focused on a singular task;
2. Enable all competing teams to compete on an even playing field;
3. Work within the facilities on campus to reduce initial costs; and,
4. Develop a project that allows for incremental development over consecutive years.

The modelling of the competition around the points above promotes the A<sup>2</sup>UV competition to be open to a wide range of universities and allows for the initial event to appeal to universities Australia wide. The collaboration of the AMCAT Society team members on the development of the competition provoked for many attributes to be advanced including: (1) Communicate effectively, (2) Work in teams, (3) Negotiate in the business environment, (4) Manage self and others (Symes, Thomas & Ranmuthugala, 2013). This single aspect of the competitions development clearly shows that integral to the progression of the competition is student development, learning and invaluable experience.

Execution of the four preliminary design elements of the competition ensures that the evolution and performance of the competition holds the best possible chance of A<sup>2</sup>UV's success. The construction of a project plan and the development of a schedule are both essential for the competition, and have been an integral aspect of the project since its beginning. The structure and drive of the students leading the development of the competition has encouraged them to become involved in producing two separate conference papers exhibiting both the A<sup>2</sup>UV competitions progression and the AMCAT Society's development success.

## APPROACH

The approach devised to tackle the four goals was designed around a structured project plan that was broken down into multiple sub-sections in order to attain achievable milestones. The strategy that was formulated comprised of not only a plan but a set of metrics that the progression could be assessed against. The initial stages defined for the start-up and growth of the competition and organisation body have been deconstructed into the following steps:

- The formation of a group of likeminded engineers with a passion for underwater vehicle technologies.
- Successful registration of a student led society with the University Union.
- Designation of society roles including the leading roles for the competition.
- Advertisement of AMCAT Society through social media and word of mouth around AMC.
- Creation of detailed project plan outlining the specific tasks and personal responsible.
- Design and draft of initial A<sup>2</sup>UV competition overview.
- Survey of universities to achieve interest in the competition.
- Circulation and revision of reviewed A<sup>2</sup>UV completion guidelines.
- Collaboration and finalisation of respective paperwork for A<sup>2</sup>UV.
- Organisation of the competition venue and teams.
- Construction of AMC entry AUV.
- Competition held.

The metrics devised for the measurement of the progress and success of the competition goals are outlined below:

- Direct feedback from AMCAT members through a bi-annual survey.
- Results from questionnaire circulated to staff and academics.
- The trends of membership and continuing involvement.
- Feedback surveys completed post competition.

The use of results comparison combined with surveys on student both apart of AMCAT and its inter-institutional activities and those who aren't, would give further insight into the positive effects of these activities and the benefits of being a member of such a society. The survey would test the perceived improvement in a student's academic performance, the perceived improvement in organisational and team working skills as well as other similar fields that would be seen as an improvement in the basic skills of being an engineer. Secondly, a voluntary grade submission is proposed to shown the academic performance of students within AMCAT as compared to those who aren't. This particular comparison would be done within an AMC subject closely related to the tasks and inter-institutional competitions that AMCAT is completing, such as *JEE354 Underwater Vehicle technology* (Forrest, 2013). This particular unit studies autonomous underwater vehicles and their applications in detail, and would be ideal for comparing and showing the improvement in a student's academic performance as a result of volunteered participation in an AMCAT activity of their interest. The combination of response feedback, academic performance and student surveys are the proposed methods for measuring the true and positive effects that AMCAT and A<sup>2</sup>UV Competition have on its members and participants and their skills as a future engineer.

## RESULTS AND DISCUSSION

The continual analysis and development of the competition is critical in being able to achieve the initial goals and outcomes as well and a successful competition likely to progress into an annual event. To quantify and prove the effectiveness of team based student lead competition style projects is no easy task.

## ACHIEVEMENTS

Since its formation and within 6 months, AMCAT and its members have achieved a great amount, providing a clear measure of the positive effects and outcomes of student lead team based projects. The AMCAT Society consists of roughly 25 maritime engineering students at different stages in their degrees, mostly first and third year students. The achievements of this small selection of students working together are as follows, and are exceptional:

- Antarctic Diver Black box, being tested in Antarctica in October
- Two AAEE conference papers
- Arduino AUV
- School students Arduino workshop
- Preliminary design of Bluetooth AUV water sampler
- Design and coding of Kalman and data filtering codes for AUV applications

All of the above achievements were entirely student driven and managed. The listed accomplishments were completed over a 6-8 month period, with the majority of team members having to learn new coding languages and writing skill in order to accomplish them.

For all of the AMCAT Society's accomplishments each member involved has worked exceptionally hard individually, and well as a team to accomplish, what are sometimes, extremely complex and advanced projects. The completion of these goals, combined with the fact that each of them was student driven and completed in their free time, shows that extra curricula team based projects can be of significant help to an engineering students education.

The involvements in inter-institutional team based projects would only enhance and improve on the results seen and gained by AMCAT Society and its past projects. The inclusion of an exciting task, combined with a competitive environment and common goal will not only improve the skills associated with team work and student projects, shown by AMCAT, but additionally provide vital engineering expertise. Team work has been attributed to multiple positive benefits for any working professional, including interpersonal communication, teamwork, group problem-solving, leadership, negotiation and time management skills (Marin-Garcia, 2007). These skills, combined with the networking and relationship skills required for an inter-institutional team lead competition, will have significant and positive effects on engineering student's education.

## RELATIONSHIPS AND NETWORKING

The old adage, "It's not what you know, but who you know," is, if not a little bit paradoxically, true for successful engineers. The ability to network and gain knowledge and experience from others is a vital tool for any professional. For an inter-institutional competition to be viable, effective and useful, skills and lessons need to be learnt by the students. The set up and administration of an inter-institutional competition by students, as well as the need for information for certain projects, develops this tool for students involved in such activities.

The success of the ability of the A<sup>2</sup>UV Competition to build communication and networking skills cannot really be quantified; therefore other methods of rating success had to be adopted. The success of communicating with other institutions to gain knowledge in this particular skill set was based on the success the AMCAT Society and its members have had in this field. The following list shows the relationships made by the AMCAT Society and its members by working with other institutions for assistance, information or Industry contacts:

- The Society for Underwater Technology (SUT)
- The National Centre for Marine Engineering and Hydrodynamics(NCMEH)
- Flinders University, Adelaide University
- Defence Science and Technology Organisation (DSTO)

The above list shows examples of relationships that were formed by the AMCAT Society. They were established by students in the AMCAT Society seeking or requiring help, as well as actively seeking to improve its resource base. This shows, that with experience and guidance students can learn to actively seek resources and information by networking. This skill not only helps the student gain industry contacts and knowledge, but also improves professional social skills, confidence, conflict resolution (Drussell, 2012) and organisational tools.

An inter-institutional competition that challenges and engages student driven teams has significant potential for the substantial improvement of students in engineering education. The main aspects of team work, networking and communication, and a competitive environment have been shown to improve the education and learning experience within the AMCAT Society and its members.

## DEVELOPMENT AND AWARENESS

Building on the need and use of networking and its benefits, the development and awareness has played an important role in the formation of the AMCAT Society, the A<sup>2</sup>UV competition and other student based projects. For student driven inter-institutional competitions to effectively engage and get the interest of students, they need to be aware that such activities are taking place.

Social media is a tool being used by billions world-wide, sites such as Facebook and linked-in are ideal for networking and awareness. With over 10 million Australians using Facebook (Stats, 2012) it was the first and most logical starting point for easy awareness and communication with a wide range of people. Figure 1 shows the AMCAT Facebook membership over time, as well as the amount of members that are actively reading and posting on the AMCAT Society Facebook page.

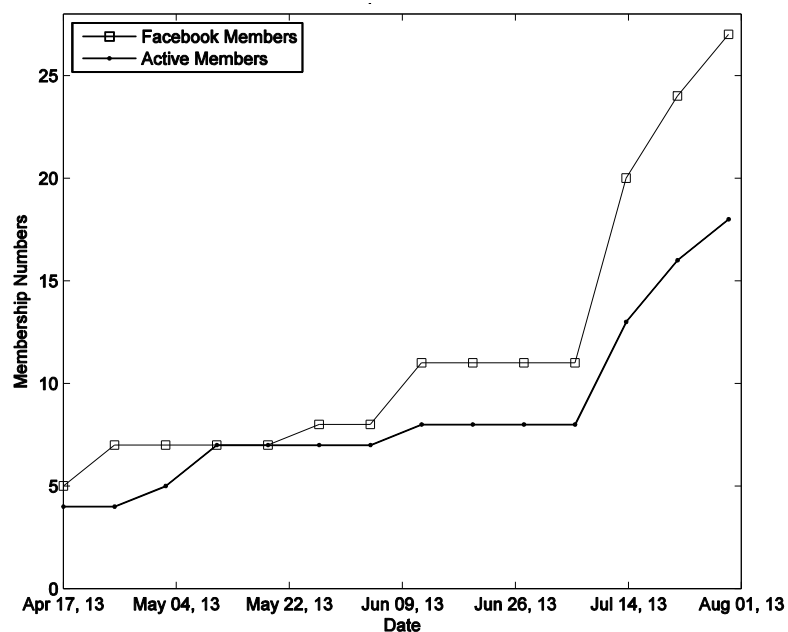


Figure 1 - Graph showing Total members and Active members of AMCAT over a period of 5 months.

From inspection of Figure 1 it can be seen that membership has been growing over the first 5 months since the AMCAT Society was formed. It can also be seen around the 5/7/2013 that there was a sharp rise in membership. This was a direct result of the societies President, Harry Hubbert, talking to the class of first year engineering students about the A<sup>2</sup>UV competition and AMCAT in general, letting them know when and where we met and to come along if interested or join us on Facebook. This direct awareness method combined with a Facebook post nearly double membership in the space of one week.

This increase in membership has led to an increase in the magnitude of projects and added to the team's knowledge base and enthusiasm. The increase in membership has enhanced the abilities of the team as a whole. As each person is different, with varying strengths and weaknesses, the more students that get involved and are passionate and interested about the projects, the better the projects progress and the better the outcome.

The use of social media and word of mouth has been proven to increase membership, and with it, a stronger team. The use of networking, team work and challenging projects encourages and intrigues all students that are willing and involved, in turn teaching them invaluable life lessons and professional skills.

## **APPROACH LIMITATIONS AND RECOMMENDATIONS**

The approach and the methods of measuring the desired goals and outcomes of AMCAT and its activities have various limitations in its current form, and subsequent recommendations to rectify them. Firstly, to truly get an overview and insight into the effects of AMCAT and its activities on its members, the survey must be appropriately designed and ethically approved in order for its results to be valid and effective. It is recommended that a relationship be formed with the UTAS School of Psychology in order to design a survey that is psychologically accurate and valid as well as full optimising the survey questions to get a realistic and effective result. Secondly, future research into the ethnicity and effectiveness of comparing the results of students. This may prove ineffective as students may have different approaches towards certain subjects. For example, one student may be very interested in underwater vehicle, and may then be part of AMCAT and try exceedingly well at this one particular subjects aimed at their interest, while another student may be more interested in the design of offshore racing boats and subsequently try less in Underwater Vehicle Technology and more on an applied ship design based subject. This may cause issues in getting accurate results in showing the positive effects of AMCAT and being a member of AMCAT. It is then recommended that this method of measurements be closely revised and improved upon, with research into similar methods as well as recommendations from ethics groups and psychology specialist be conducted.

## **CONCLUSION**

In summary from the initial development of an inter-institutional student based project it can be clearly stated that the AMCAT Society developed A<sup>2</sup>UV competition has a recognisable magnitude of potential, and progressive analysis of the project provides strong results so far. There has been a substantial response to the competition and AMCAT Society, with proposals and expressions of interest being sent and received by various universities Australia wide. Although there is no confirmed date for the A<sup>2</sup>UV competition, the inter-institutional bond between AMC and Flinders University for the Robot-X competition is confirmed and underway for the 2014 competition. The expertise and skills gained by students in having to organise and lead a large scale competitive project provides a multitude of benefits that will assist them in whichever field of engineering they wish to pursue.

Further research includes looking at the effectiveness of the AMCAT Society and the produced student outcomes and benefits of the competition in years to come. Comprehensive surveys and reviews of future inter-institutional student led competition participants will be undertaken to understand and quantify the hypothesised positive effects of such activities.



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