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Promotion of STEM subjects in Scottish schools through the MATE Scotland ROV Challenge

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Abstract— in this paper we will introduce the Marine Advanced Technology Education (MATE) International Student ROV Competition and the development of the Scottish Regional Event that feeds into it. We will present case studies from teams that have taken part with particular reference to the influence it has had on the teaching of Science, Technology, Engineering and Mathematics (STEM) subjects in school and the career choices of school-leavers. We will also present the industry view from team mentors, judges and sponsors from companies supporting the MATE Scotland ROV Challenge.

Keywords—education; science, technology, engineering, math; remotely operated vehicle; marine advanced technology education

I. INTRODUCTION

The MATE International Student ROV Competition is for school, college and university students and involves the design, construction and competitive evaluation of underwater robots or Remotely Operated Vehicles. Each year, new mission tasks are set, based on real subsea operations. Within the limitations of technology appropriate to the age groups and educational level, the ROVs are functionally equivalent to those encountered in industry. Teams are encouraged to see themselves as entrepreneurs and be involved in the non-technical aspects of bringing a product to market as well as meeting technical specifications and solving technical challenges.

The work is presented to judges from industry in the form of practical, competitive, demonstrations, technical and non-technical documentation and oral presentations. There is a strong emphasis on safety as well as design, performance and teamwork.

The competition comprises four different classes to cater for younger or less experience teams, through to older and more experienced teams and is open to children and young adults in full-time education. The majority of participants are in secondary, further and higher education with younger participants in later stages of primary or middle school education also participating. The annual competition cycle is in

two phases with Regional Contests which, for the senior competition classes, feed into an International Competition. In general, the location of the International Competition varies from year to year and is hosted by one of the Regional Organizations. Over 60 teams took part in the 2016 International Final, which was held at the NASA Neutral Buoyancy Laboratory in Houston, Texas.

MATE Scotland ROV Challenge is one of 31 (at time of writing) Regional events, of which 11 are outwith the United States.

II. MARINE ADVANCED TECHNOLOGY EDUCATION CENTER

The MATE Center in Monterey, California was established in 1997 under the National Science Foundation Advanced Technology Education program. Its mission is to “use marine technology to inspire and challenge students to learn and creatively apply Science, Technology, Engineering, and Math (STEM) to solving real-world problems in a way that strengthens critical thinking, collaboration, entrepreneurship, and innovation.” The ROV competition may be the flagship event, but its success is built on a broad program of educational support activities based on a clear mission, goals and strategy [1]. The emphasis of the ATE (Advanced Technology Education) program is on two-year colleges (HND in UK parlance) and focusses on the education of technicians for the high-technology fields that drives the US economy [2]. The MATE ROV competition and the support that underpins it has developed to encompass earlier stage education necessary to feed this requirement and also the four-year undergraduate degree courses that follow. The first MATE Student ROV Competition took place as a single event in 2002 [3] and program has attracted a growing international following, initially with Regional Organizations in Canada and Hong Kong [4] but now more widespread.

Supporting activities and facilities include workshops for participants, teachers and regional organizers and the MATE website hosts educational material for participants and teachers preparing classes and technical forums. MATE also arrange internships and encourage participants, particularly those about

to graduate, to register as Alumni to seek employment or further education in the sector.

The MTS and IEEE OES along with many other international companies, organizations and educational establishments play a significant role in supporting the MATE International Student ROV Competition, as sponsors, mentors judges and volunteers. The impact of the competition has been reported in a study of the first ten years of operation [5].

III. MATE ROV DESIGN AND CONSTRUCTION

Knowledge of and familiarity with ROVs amongst the general population is not widespread. Construction of working ROVs, even “models” intended to dive just a few metres is not trivial. The inspiration behind the competition that demonstrated that “appropriate technology” suitable for educational need could be applied to ROVs is a book of experiments and projects for children [6]. One consideration in the construction of an ROV by non-professionals is a simple inexpensive and reliable means of providing thrust. This was solved, and published in this work, by the use of electric bilge pumps intended for use in small boats. The material has been developed and extended in partnership with MATE into an extensive text on the subject appropriate for high school and undergraduate readers [7].

The second critical component, an inexpensive underwater vision system. Many teams use commercial so-called “fish finder” camera systems, though for the depths involved (3 m to 10 m) waterproof housings can be made from readily available materials such as plumbing supplies. Hardware store materials are also the components of choice for ROV frames, particularly for new teams, though the availability of 3D printers and laser cutters in some schools has widened the choice.

Simple switched bang-bang control can suffice with the low excess thrust common with the use of simple bilge pump thrusters, though the rise in popularity of aerial drones and the availability of powerful brushless DC motors and controllers has opened up possibilities for proportional control and many experienced teams move on to use microcontroller control.

IV. MATE INTERNATIONAL STUDENT ROV COMPETITION

The competition is divided into four age and experience related classes:

- SCOUT – the beginner’s class, suitable for ages ranging from upper stages primary school. The competition is offered at Regional level only. Initially, the rules stipulated that the thrusters (for fresh water use only) need not be waterproofed, though this is now required. Small, low voltage model ROVs without waterproofed motors have been used in educational workshops [8], [9]. The ROVs need not have cameras and are piloted by viewing from the surface and the tasks are designed with this in mind.
- NAVIGATOR – this class was introduced in 2014 as an intermediary between SCOUT and RANGER class and is offered at Regional level only. The standard of design and performance at the senior levels had advanced considerably leading to a significant jump from SCOUT class. The

general requirements are similar to RANGER class but the mission tasks are less complex.

- RANGER – this is the primary competition class. The first round of the completion is held at the Regional level in April or May with the winners qualifying for entry to the International competition in June. Teams are generally from high schools. There are exceptions such as teams too remote from a Regional Competition. Where Regional Contests have 11 or more schools completing the contest, two teams may go forward to the International Competition.
- EXPLORER – the majority of teams are from colleges and universities, though high school teams that have competed at International level can apply, subject to conditions relating to performance and continuity of team membership. Entry to the competition is by invitation subject to proof of performance. There is no direct competition at the Regional level, though some Regional organizations arrange demonstration events or hold independent “play-off” contests.

Competition entries are judged on a number of criteria, in the form of a Request for Proposals set out each year in the Competition Manuals for each competition class and published on the MATE web site. Teams are encouraged to “think of themselves as “entrepreneurs”” [10]. There are a number of assessed or required elements:

- Product Demonstrations (pool missions). This element attracts the most points, typically half the total score. Teams have just 15 minutes to complete typically 4 separate tasks that are split into smaller sub-tasks. Generally there are more tasks than most teams can complete within the time in order that there is sufficient challenge for the top finalists. The best score from two attempts is taken.
- Engineering and Communication. This comprises three elements: Technical documentation (20 page written report), Product Presentations (15 minute oral presentation and 15 minutes of questioning) and Marketing Display (poster).
- Safety. MATE is very particular about safe operating practice during design and construction and at the competition. Before an ROV permitted to enter the pool, it must pass a safety inspection. Teams are given three opportunities to make good any failings. A new element for 2017 is the addition of a Job Site Safety Analysis. Teams are also observed and marked on their application of safe working practice at the pool. Teams wishing to use hydraulic or pneumatic power or laser-based instrumentation must pass appropriate assessments before the competition.

Certain parameters in the competition such as supply voltage and current limit remain constant, though the mission theme varies every year. There is no limit on the budget but the points for technical design and innovation are strongly biased towards teams designing and building their own components

rather than buying ‘off the shelf’. There are strict limitations on input from teachers, mentors and other outside helpers.

The annual competition theme is informed by the location of the International final competition to draw attention to different aspects of ROV and subsea operations. Generally there is a balance of industrial/commercial, scientific and environmental elements to the theme present each year. With the 2017 International completion being held in Long Beach, CA, the theme relates to the harbour and seafront and commerce, construction, entertainment and ecology. Past competitions have taken as their theme, topics ranging from energy production, underwater archaeology, arctic operations and underwater volcanic activity.

The annual timeline is as follows, though most established teams will commence preparation for the following year as soon as the previous design is complete.

- October – release of the mission preview giving the overall theme
- November/December – publication of the full competition manual detailing the missions scoring and technical and safety rules.
- January – formal registration opens.
- April/May – Regional Contests
- June (third week) – International Competition. The location of the next competition is announced.

V. MATE SCOTLAND ROV CHALLENGE

The MATE Scotland ROV Challenge was set up in 2007 following participation by a group of RGU students at the MATE International Competition. The experience gained, enabled the holding of an Aberdeen schools in-service day seminar for principal technology teachers, organized by Maureen Traquair, then of OPITO and Young Engineers and Science Clubs Scotland. Four City schools agreed to take part in a pilot run of the competition with the first Scottish Regional Contest taking place in April 2008 with the regional winners, Bridge of Don Academy going on to win “Rookie of the Year” award at the international competition at the University of California at San Diego. At the time BP and RGU had recently entered into long-term partnership which has seen BP support the MATE Scotland Challenge and many other student-related activities. This, along with other sponsorship has enabled the winning team to travel to the international competition each year.

Many of the teams entering the MATE Scotland ROV Challenge are formed around secondary school Young Engineers Clubs running as lunchtime or after-school clubs. Scottish Young Engineers and Science Clubs is run by SCDI (Scottish Council for Development and Industry) [11], [12]. With the exception of the major cities, population density in Scotland is low. The catchment area for rural secondary schools is wide and pupils rely of school transport. This means after-school activities may be limited and many teams rely on working on their ROVs in short periods over lunchbreak. This can have a detrimental effect on mentoring where industrial

volunteers are generally available only in the evenings. Additionally, though the distances may not seem great by international standards, the transport infrastructure can make travel to central meetings and workshops time-consuming. On the other hand, a number of schools are community facility centres meaning that access to swimming pools for ROV practice is possible. Credit is due to the teams and their school mentors for maximising the opportunities open to them.

Some Regional Contests run over more than one day, often a weekend. This is not practical so the MATE Scotland ROV Challenge takes place in a single day. This can call for a very long day for distant schools. MATE does not require Regional Organizations to include all competition elements but prefers that they offer as many as practical. By scheduling distant schools to start later, by running multiple parallel sessions and though the very generous support of ample judges from industry we have for the first time in 2017 been able to include all assessed elements including two mission attempts.

The timetable for the MATE Scotland differs slightly from the main competition in order to fit the Scottish school calendar. Schools are contacted in mid to late August at the start of a new session to register interest. An induction meeting takes place in October to confirm interest. The meeting includes a workshop on MATE rules, construction techniques and the mission preview. If sponsorship allows, new teams are presented with an underwater camera kit. Also, if sponsorship allows, each team is presented with pump-priming funds of about £300 in two tranches, the second part being delivered in the new year on confirmation of progress. A second meeting takes place in February to review the competition “props” (subsea objects the ROVs will interact with) and competition missions. Judges and mentors are also invited to this meeting.

VI. PARTICIPATING SCHOOLS AND ORGANIZATIONS

The Challenge has grown steadily over the 10 years that have followed. Initial interest has reached 16 teams with typically about 12 schools registering. The maximum number of teams competing on the Challenge day is 11 and as a result on two occasions (2012 and 2016) two Scottish school teams took part the International Competition. Having started in Aberdeen, the majority of teams are from the North East of Scotland, but teams from other regions take part and the organizers and sponsors are keen to encourage this. Most teams are based in secondary schools, but over the past two years there has been interest from Sea Cadets teams. Participating schools and organisations (with the years they went forward to the International completion in brackets) include:

- Aberdeen City: Aberdeen Grammar School, Aberdeen Sea Cadets, Bridge of Don Academy (2008), Bankhead Academy, Bucksburn Academy (2010, 2012), Dyce Academy (2009), Hazelhead Academy, Robert Gordon’s College (2012, 2016).
- Aberdeenshire: Banff Academy, Keith Grammar School (2017), Mackie Academy, Stonehaven, Mearns Academy, Mintlaw Academy (2013, 2014, 2016), Peterhead Academy (2015), Westhill Academy.

- Central Belt and East Coast: Bannockburn High School, Craigmount High School, Edinburgh, Menzieshill High School, Dundee (2011),
- Highlands and West Coast: Fort William Sea Cadets, Nairn Academy, Oban High School.

Schools from two very different locations are considered here in greater depth. The first is a small rural Aberdeenshire school and the second an inner-city school in Dundee. Both have won the Regional competition and perform admirably at the International competition.

VII. MINTLAW ACADEMY

A. *Please give an introduction to your school and its involvement in the MATE competition.*

Mintlaw Academy is comprehensive secondary school with approx 750 pupils it is situated at Mintlaw, a small village in the heart of the Buchan Area in the North East of Scotland. 10 miles west of Peterhead it is a rural community with farming in its heritage with a strong background of sporting and engineering excellence. The technology faculty, Mintlaw Tech has been building industry and university links for ten years and is now recognised as one of the lead schools in partnership working in the area.

Mintlaw Tech have been part of the MATE competition since 2012 – the school had been looking to run a team since the regional competition started but it wasn't until a group of S3 boys showed an interest that we began what has become a life changing experience for a range of secondary school pupils and the staff.

Our first competition entry was 2013, where we thought we were dipping our toe in the water and hopefully giving the boys an experience of what engineering is really about. What happened that day in March changed the outlook of the Faculty of Technology and the pupils. We have been lucky enough to travel to Seattle, Alpena, Michigan and Houston, each time we have improved our vehicle and the manner in which we approach the competition.

The trips to the USA have provided our pupils with a once in a lifetime opportunity to meet people from different countries and cultures. Some of them experienced flying for the first time, America for the first time and even being away from their parents. 2016 was a particularly memorable trip being at the Neutral Buoyancy Lab at NASA it provided a real behind the scenes look at the work NASA does in preparation for space station visits and also the missions to Mars. It was an inspirational and very educational trip.

The school is immensely proud of the achievements of our ROV group, they continue to push the barriers of what they can achieve, committing hours of work to prepare for the competition each year.

Now a weekly club and timetabled wider achievement group, we strive to provide pupils an insight into the subsea world and also the work required to run what is a ROV company, from designing and constructing the vehicle and controls to making marketing material, technical reports and

presentations. This is without a doubt the best experience I feel I can offer the pupils. We have a large amount of industry engagement allowing pupils to forge relationships with Multi-National companies, using them as sources for information and equipment. Our industry mentor from BP, Neil Stagg has become a friend of the school and of the pupils, the relationship the pupils have with him is without a doubt one of the strengths of the program.

Now in your 5th year we continually strive for improvement the 2017 model completely breaks the mould of our traditional vehicles and enhancement and controls have made it a different challenge for the pupils.

B. *What has been the impact of taking part in the MATE programme?*

Since we have started we have introduced the program to primary schools with our outreach program which has proved to be very popular with children building and piloting small ROVs in the space of an afternoon. We have a range of pupils who are keen to take part in future competitions and activities.

As a school we have been awarded the Pride of Buchan award on two occasions, the first engineering activity to be awarded it. The team have supported the MATE stand at the Subsea UK Expo on three occasions and have presented at the dinner to industry professionals to support the work of MATE and the subsea industries in the North East of Scotland.

Building partnerships has been a real benefit to the competition as the young people feel confident discussing the industry with professionals from a range of different backgrounds and levels with their respective companies.

C. *Has taking part had an influence on participants and if they have left school what they are doing now?*

The competition has provided a platform for our participants, we still have 6 of our team at school who are pursuing a range of different careers within the engineering sector or the supply chain. Currently we have a highly academic team who are fully committed to their studies with the 3 girls going to attempt 5 higher each in the 2017-18 academic year. Ben is currently in S6 and is looking to start university in 2017 in the field of Electrical Engineering. Robert is waiting to get confirmation about a range of apprentices he has applied for.

The first team were a more practically minded group. Kieran is now in his 3rd Year of the RGU Mechanical Engineering degree where he has been performing very well, Liam is about to complete his apprenticeship as a helicopter technician with CHC Helicopters. Douglas is currently studying electrical engineering at NESCol in Fraserburgh, David is currently on an engineering apprenticeship and Gareth has taken a gap year from studies.

The participants come from a range of different backgrounds and bring different skills to the activity, not always engineering, the best teams have a balance between engineering and research based skills.

D. Has taking part in the MATE programme had an impact on teaching and facilities and if so, what are they?

What started as a lunchtime group has transformed into an after school club with timetabled opportunities for S5 and S6 pupils, this past year has provided an opportunity to develop skills of the pupils, they have learnt Arduino programming, (way beyond my level of skill) design, CAD and CAM techniques which allow for them to build on knowledge previously limited to the curriculum.

This year we have introduced a 2000 litre test tank with underwater surveillance capabilities which has proved beneficial. For continual testing of the vehicle and sub components. The opportunity to work with primary schools has proved beneficial.

We have built up relationships with a range of different companies, who not only provided support and guidance to us but the competition as a whole. This has resulted in Mintlaw Academy becoming known as one of the forerunners in the Developing Young Workforce national agenda with Education Scotland recognising the achievements of the programs we run in the school.

The mind-set of the staff is to provide keen pupils with the tools to succeed, if they use them they will be successful, we encourage pupils to create the level of pressure themselves to succeed.

E. What plans do you have for the future

We aim to grow the program and reach out to more Primary schools, providing a more challenging experience for them and for our senior pupils who deliver the activities. With a view to running our own NAVIGATOR or SCOUT class competitions in our own test facility.

In terms of the competition we aim to continue to bring pupils through our program, this next year will see the creation of a formative curriculum based on the competition allowing pupils to specialise in a particular field of study.

This competition changing young people's perception of Engineering and for our pupils has been undoubtedly life changing!

VIII. MENZIESHILL HIGH SCHOOL

A. Please give an introduction to your school and its involvement in the MATE competition.

Menzieshill became involved in the MATE ROV program back in 2009. And competed in the competition until the school closed in 2016. Menzieshill was an inner city school based in one of the more challenging areas of the city of Dundee.

The ROV was a focus for several of pupils who showed an interest in Engineering. The school did not run any of the traditional engineering subjects like Engineering Science or Technological Studies at that time. The team would come for a couple of lunchtime sessions each week. This expanded rapidly such was the interest. We gained support from parents and through that we were mentored by SP Technology an engineering company in the city.

We competed in every competition from 2009 until recently when the school closed. We were successful in every year but also won in 2011 and competed internationally in Houston USA.

B. Has taking part had an influence on participants and if they have left school what are they doing now?

I could list multiple pupils who gained much more than experience from their involvement in the program. I will focus on four pupils who have used the experience as a springboard to their careers.

Nicole was part of the team for 2 years. She qualified as a Design & Technology teacher in 2016 and is currently completing her probation year at St Pauls Academy in Dundee. Nicole became involved in the ROV program as a result of her relationships with teachers in the D&T department in Menzieshill. She enjoyed being in the department and was inspired by her teachers. She soon became involved in the ROV team and has used the experience to help her gain entry to university. Her teaching is contextualised using her experience in the program. She continued to support subsequent teams long after she left Menzieshill. Nicole by her own admission felt uneasy about becoming a teacher given her age and lack of engineering experience but feels that the program has helped ease the way.

Craig was involved for over 4 years. Craig piloted the winning vehicle in the 2011 competition. He is currently studying Mechanical Engineering at Dundee University. Craig had a strong interest in engineering prior to his involvement in the program. He had a keen interest in RC car racing as well as Go cart racing both of which involved him building his own vehicles. His involvement in the team allowed him to expand his engineering skills in a completely different way. Craig embraced the concept and has continued to be involved in the program right up until the school closed in 2016.

Rebekah was involved for 2 years. She is in her final year at Glasgow University where she is training to become a teacher of Design & Technology. Rebekah became involved in the ROV program as a result of her relationships with teachers in the D&T department in Menzieshill. She enjoyed being in the department and was inspired by her teachers. She soon became involved in the ROV team and has used the experience to help her gain entry to university. Rebekah has used her experience to contextualise her placement lessons. Rebekah continued to be involved in the program right up until the school closure

Molly was involved for 3 years. Molly, like Rebekah is studying to become a teacher of Design & Technology. She is currently at the end of her second year at university. She says the involvement in the department and the ROV program are what have shaped her future. Molly had little interest in engineering until she started studying in the D&T department at Menzieshill. She saw others working on the program and got involved. The impact was significant and she now sees engineering and teaching as her future.

These are only a few examples of pupils who have benefited from their involvement.

C. Has taking part in the MATE programme had an impact on teaching and facilities and if so, what are they?

My teaching has changed radically since first being involved in the program. My intention was to use the ROV as a basis for a lot of the work in S1 & S2. The school closure has obviously stopped this.

Grove Academy (a new chapter). I moved to Grove in August and immediately set about introducing the ROV program as an extra-curricular club. The pressures of having a new post and illness meant that we did not compete this year. We are however firmly committed and have been given the go ahead to have a timetabled class based around the engineering and construction of an ROV. The future at Grove in terms of MATE is very bright.

IX. MENTORING, JUDGING AND INDUSTRIAL COLLABORATION

All participating teams require a mentor who will guide the team but should not play a material role in the design and construction of the ROV. The primary mentor for a school-based team will often be a teacher and in the MATE Scotland ROV Challenge the majority are Technology or Physics teachers. The organizers encourage teams to work with a mentor from industry where possible and pairs teams and mentors. We have followed the lead of the SETPOINT/Go4SET initiative as identified by U.K. parliament in this respect [13] in encouraging teams to work with local industry. Given the location of location of the MATE Scotland ROV Challenge base in Aberdeen, many mentors are actively involved in subsea engineering, but this is not a requirement. Guidance in matters of project management, financial planning, documentation, presentation skills and many other areas are of value. Some technical knowledge is an advantage, but the wealth of documentation available through the MATE web site and Regional Coordinator covers most topics.

An essential role in MATE events is that of competition judge. MATE prepare detailed competition documentation, judging rubrics and hold on-line seminars and forums on preparations for the competition. Part of the role of Regional Coordinators and their teams is to pass this information on to judges. The majority of MATE Scotland ROV Challenge judges are industry volunteers and are keen to return each year. An induction meeting is held and judges along with representatives from each team are invited to view the “competition props” and a run through of the missions. MATE asks that the majority of the elements of the competition are covered at Regional Events, but accepts that resources may limit this. In 2017, the written report element of the competition was introduced to the Scottish Regional and was assessed by judges from industry.

Industrial collaboration takes other forms too. Mentors are encouraged to arrange visits to their companies and Oceanering have organized open days in which teams learned about ROVs and ROV operations and had the opportunity to operate an ROV simulator and operate an inspection class ROV in a test tank [14]. After the Regional heat, the winning team practices and refines their documentation prior to the International final. A valuable experience is the presentation by

the winning team to staff at BP and the feedback session that follows.

Feedback from industrial mentors and judges has been encouraging.

A. As a mentor do you see any change in teams (e.g. life skills as well as technical understanding) as they gain experience developing their ROV and taking part at Regional and International level?

Enormous changes in:

- Life skills and citizenship and relating to other students whilst working as team. Really a little similar to a sporting team where team adhesion is critical to win.
- Self-confidence and speaking to adults / others not normally within their personal social circles.
- Awareness of the wider world, particularly with Regional winners at international finals. As I tell my “students”, “the world goes further than the chipper at the end of the street”
- Reminds me that talented students WILL succeed no matter the hardship (and it also reminds the students)

B. Do you think that participants perception of industry is altered by taking part – and in what way?

- Yes- absolutely!
- The competition gives excellent grounding and awareness of the real world out there that eventually (sooner for some) they will have to go and join to make their livings and way in the world. The themes (missions) of the competition are generally based around “real life” efforts being undertaken concurrently by professionals somewhere.

C. What do you think about the “MATE model” of bringing together students of different ages together with teachers, researchers and industry professionals?

Perfect

D. What do you feel that you get from being a judge at regional and international level?

- The offshore and underwater industry has been exceptionally good to me. It’s a chance to give “a bit back” where I was helped. I get a huge buzz from seeing students having fun while grasping and working the missions.
- Over a short few years I have already seen a number of students realise and grab the chance that MATE offers to broaden their life and career skills. This brings a lot of satisfaction at seeing these individuals progress after MATE. Most do not go into EXPLORER Class mainly through pressure of tertiary studies (that is unfortunate).

- It gives me a chance to catch up with old friends and colleagues from within the industry. I generally know (or know of) someone in most (subsea) corners of the world.
- I have some fun!! (if I'm not worrying about work to go back to)
- It also reminds me that the industry is racing technologically and MATE gives me a way of being aware of new ideas and thinking (yes! I learn a lot each year- from MATE students- especially EXPLORER class (and by the way that is why many of the technology companies are involved- to pick up new ideas)

E. What do you see as the benefits to industry in contributing to the MATE competition?

It's quite clear to me:

- It is assuming some "community responsibility" for how well students are "equipped" to go onto the employment market in the future.
- It is nurturing / encouraging free thinking around technical ideas- so valuable for students to acquire
- Promoting a technological theme of which the outputs are highly sought after in industry
- Develops a technical problem solving mentality in a friendly and fun atmosphere – highly regarded in industry recruitment
- Industry can be exposed to a new ideas and technology base they have no way of tapping into (en-mass)
- Promotes citizenship and awareness of the "wider world".

F. Is there a way in which industry could contribute in a more effective, efficient, productive or other way?

We can always improve MATE and how it is administered.

- I think the present foundations are solid though.
- Of course it takes money to run the programme, so obviously exploring promotion and growth issues come back to funding – and is important to continually solicit.
- Mentors coming from industry are (very) important.
- Promote the safety aspects.
- We could establish a MATE / Regional Organization / joint industry committee.
- We can even go further than the MATE concept by introducing related (affiliated) aspects as use the MATE programme to train non technology students, e.g. MATE marketing, patent law, etc.

X. FINAL WORDS

The MATE Scotland ROV Challenge has grown steadily over its ten years of operation. Early expansion suggested that it could presently be larger than it currently is. The recent national recession and international situation regarding energy prices has had an effect. This may have restricted rapid growth, but it has had little effect on core participating schools and industrial supporters, though resources are tight. A small sample of past participants shows that taking part appears to have made a significant impact on personal development and career choice and has benefitted the schools and departments involved. The Challenge is enthusiastically supported by those in industry taking part.

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