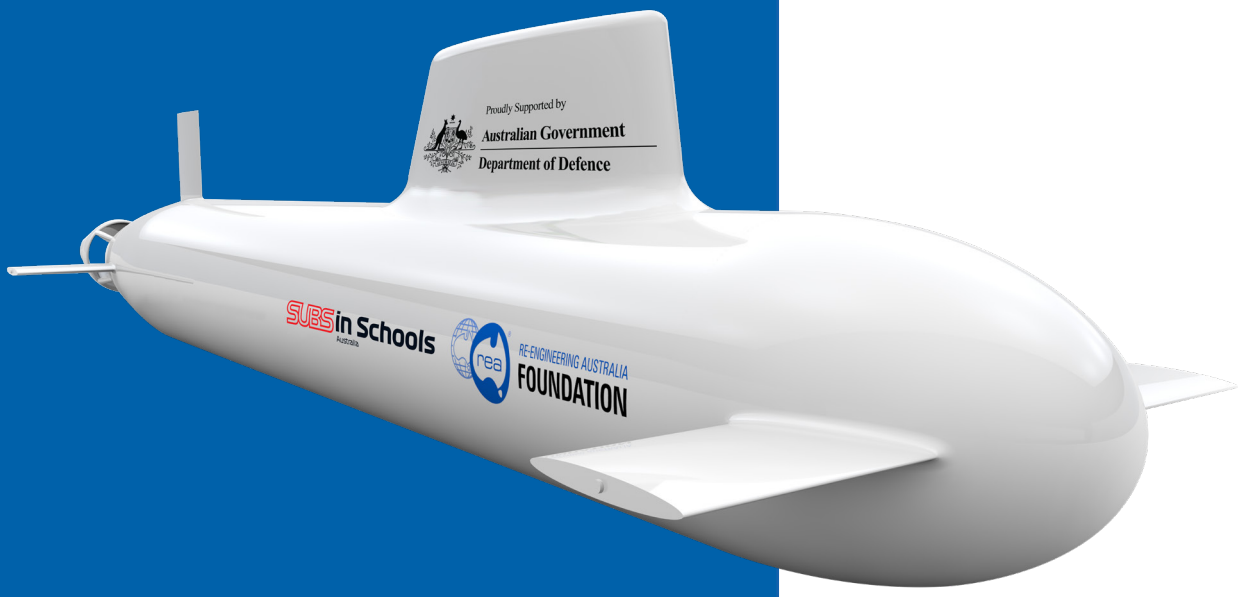
SUBS™ in Schools Australia

RE-ENGINEERING AUSTRALIA FOUNDATION



INTRODUCTORY OVERVIEW

An introduction to SUBS in Schools in Australia

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About REA

Re-Engineering Australia Foundation (REA) is a not-for-profit charity focusing on the implementation of a STEM 4.0 Life-long Learning platform which takes the concept of STEM education to another level. By focusing on the development of the analytical problem-solving capacity of students and by the development of their communication and collaboration skills, we help build resilience and character in students, preparing them for the world of work and their future careers.

REA's programs promote career relevance, supporting the transition of knowledge from primary school, through high school into university and directly into industry. We want students in primary school to start the process of developing a set of skills based on analytical problem-solving & communication that they can take with them and build on as they traverse high school and into university or a career.

What is STEM

STEM is a methodology designed to integrate the four educational disciplines of science, technology, engineering and mathematics into a learning environment based on real-world applications and real world problem solving.

STEM is not just about more mathematics and more science but rather a curriculum based on the concept of educating students in an interdisciplinary and applied learning method. STEM education has proven to create more enjoyable learning, catalysing innovation and creating more capable students.

Why SUBS in Schools?

The SUBS in Schools program is founded on a STEM 4.0 philosophy which builds links with industry and real-world career relevance for students. It aims to facilitate a cross-curricular learning platform which builds in students the employability skills industry is seeking. The program is open-ended, and students can achieve at a level that fits with their skills and desires. It also provides a platform where students can go on to compete on a world stage.

SUBS in Schools is currently developed and led by Australia and is being launched in the UK & Thailand.

Background

Re-Engineering Australia Foundation, in association with the Australian Department of Defence and a number of industry stakeholders have developed the SUBS in Schools program for Aussie kids. The program is focused on engaging student interest in the technology of submersible vehicles and submarines, and is built on the fundamentals of project-based learning.

SUBS in Schools is a high level STEM project where students have the opportunity to learn about complex Engineering Systems and build an operational Remotely Operated Vehicle (ROV) or submarine.

Four levels (4) of participation exist within the SUBS in Schools program with each level designed to help students explore scientific, engineering, materials and manufacturing techniques, which are focused on different levels of complexity.

Underlying these activities is an educational pedagogy which develops employability skills (21st Century Skills) in students which will aid their transition to the world of work. These skills include communication, collaboration, presentation, teamwork and entrepreneurship, all of which are highly sought after by industry and invaluable in business environments subject to disruptive technologies.

A fundamental and key differentiator of SUBS in Schools is the requirement for students to work directly with industry partners in the context of their projects.

The tasks faced by the students within SUBS in Schools are no less complex than that faced by engineers working on real marine projects and thus the opportunity to collaborate with industry, as a means of solving these problems, will help to develop the communication and collaboration skills of the students.

Program Fundamentals

Students participating in SUBS in Schools follow the process of Design, Analyse, Make, Test, Trial and Review as they create an Remotely Operated Vehicle (ROV) or Submarine. The journey for students is an iterative journey where they undertake research, come up with concept solutions and then manufacture and test their ROV or Submarine.

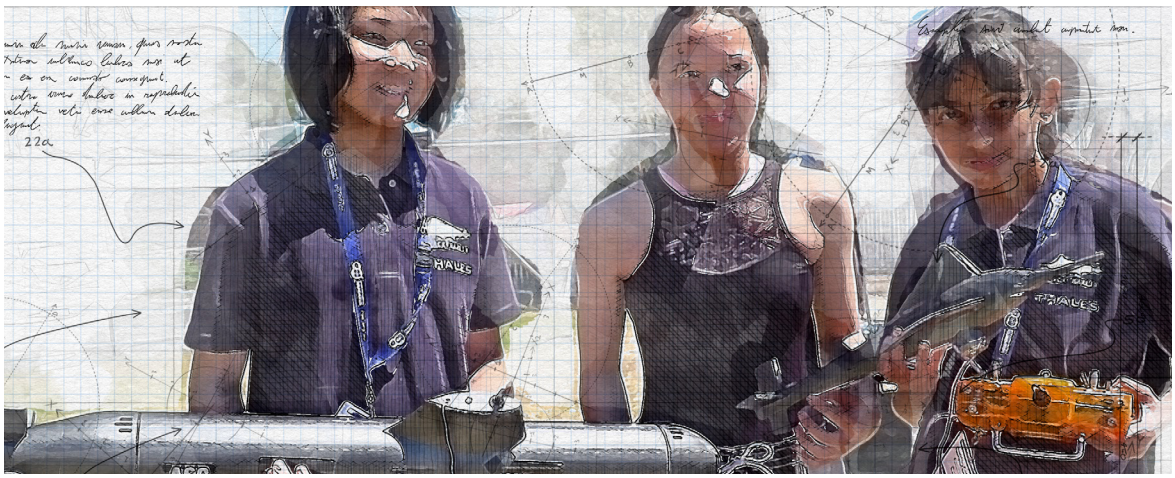
SUBS in Schools is based on STEM 4.0 and Action Learning (AL) principles, which have an extended trajectory in terms of the involvement of the students and the outcomes that are achieved.

They will most likely make mistakes along their way and acquire new learnings which will facilitate them revisiting their design to apply improvements. They can then go on to compete against other students within their school, their state, their nation or progress to representing Australia at an international SUBS in Schools event. The students can choose how far along the competition journey they would like to travel.

Our experience has shown that programs which engage intrinsic interest over extended periods of time achieve a much higher impact in influencing children's career decision choice.

The goals of SUBS in Schools are to:

- Bring career relevance to STEM learning activities and excite and encourage students to consider careers and a learning pathway related to STEM.
- Develop skills in students which are directly transferable to industry roles
- Provide alternative learning and skills development in schools that build employability skills in, and equip students with, increased employment options.



- Facilitate a cross-curricular education environment to enhance the outcomes of the education system.
- Promote innovation and the development of entrepreneurship in young people.
- Increase the number of students taking up STEM based careers in support of satisfying the skills requirement of large-scale engineering programs.
- Provide a catalyst for encouraging interaction and collaboration between schools, industry and the community.
- Ensure that Science, Technology, Engineering and Mathematics becomes a part of the everyday language of students.

SUBS in Schools is structured to allow teachers and students to develop their understanding of design and technology over time.

Designing an ROV or Submarine will require the formation of a team involving several students, all with different skills. As with any engineering design project team, they will need expertise in engineering, management, industrial and graphic design and industry collaboration. Research shows that teams formed from non-heterogenous groups of students continuously outperform heterogeneous groups.

Depending on student skills and interests, they may focus on different aspects of the project.

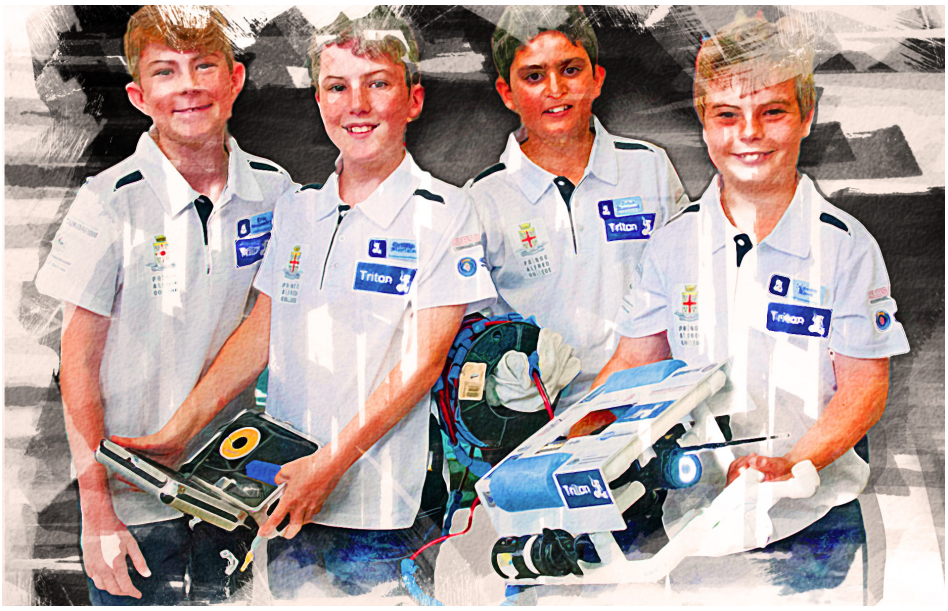
Building skills in 3D modelling is an essential component of the initial design phase. It is crucial however, for students to realise that SUBS in Schools is much more than just a model.

Students new to the program sometimes spend a large portion of their time thinking about different design criteria before producing a viable design. They need to be careful not to over-focus on one element of the process.

Students experienced with the process split the components of the design-manufacture-marketing process between team members and select a team manager early in the planning phase. The manager's role is to keep the team on track. They should understand the importance of each component of the project sharing time and resources between the different team members.

Students must document the processes and decision making they undertake throughout the project. Recording progress is great classroom practice but also allows students to look back on their work and understand how they have developed a concept to produce a final product. Recording observations is also invaluable when it comes to competitions as it gives students a range of data to select from when developing their portfolios.

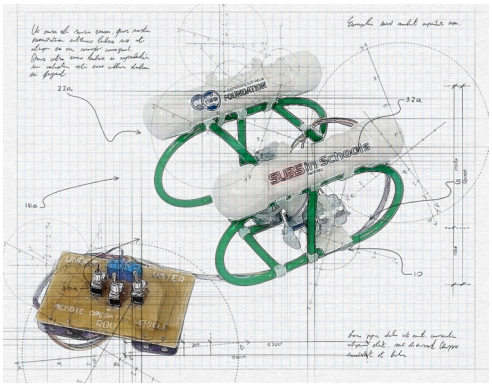
Students will go through the design to review process multiple times before reaching a practical design. By the end of their SUBS in Schools journey, the students will be able to look back and realise that they have enjoyed the possibly hundreds of hours they have spent learning. The process of bringing an idea into reality is empowering, helping them identify their capacity to produce solutions to real-world problems.



Stepping Stones

Level 1 - Build a Mini ROV

Is designed for students in years 5 - 8 as an introduction to STEM and underwater vehicle operation. The task is to build and operate a mini ROV with the focus being on learning the principles of buoyancy, propulsion and control. Small ROV model kits, together with instructions, are made available to the schools.

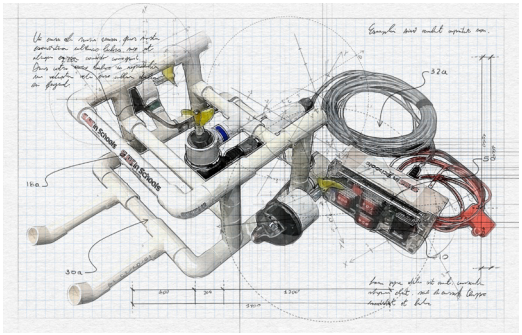


Level 2 - Design of a Large ROV

This is aimed at students in years 5 - 12 and involves a much larger component of design and construction. Students are required to build a larger scale ROV, able to support ancillary items such as cameras, robot arms and the like and able to undertake specific underwater tasks. At this level the students will be required to extend their understanding of the maths and science around underwater operation together with robotic control.

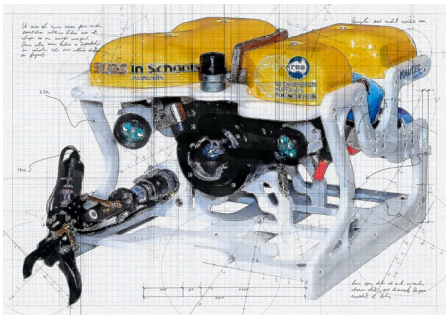
Development Class

Students in years 5 - 9 build their ROV from a standard development class kit. Students must focus on buoyancy, performance, the addition of cameras and devices that allow them to pick up objects during the sea trials.



Professional Class

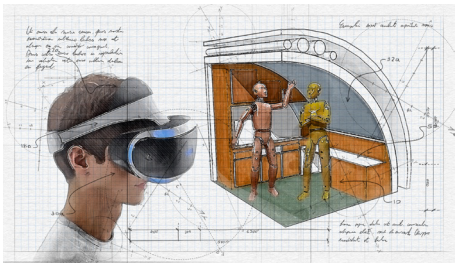
Professional class is an open design category where students from years 6 - 12 have the freedom to design and build within constraints of size only.



Level 3 - Spatial Design

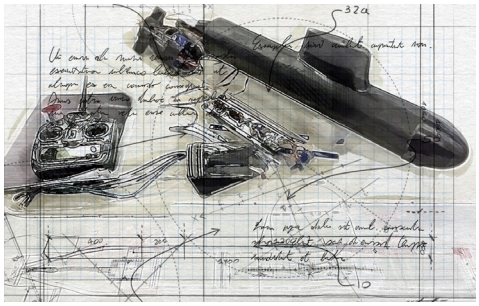
The task is to form a virtual design company, which will make a bid for the design of an accommodation space on-board a future submarine project. The students will then bring this design into a virtual reality environment to demonstrate their design.

This level is designed for students in years 7 - 12 and is well suited to schools who do not have a significant workshop facility.



Level 4 - Design and build an Operational Submarine.

At Level 4 students in years 7 - 12 take on the design of an operating scale submarine. The task is to form a new design company from 3-5 students to design and build a new remotely operated submarine. The submarine must work within an operating environment defined by a set of rules.



Implementation In School

Coordinating SUBS in Schools at your school

SUBS in Schools can be implemented in a variety of ways. It's essential to consider the learning context within your school before developing an implementation plan. There is no relationship between how schools implement the program and success, even at an international level. Schools will have processes in place, which will influence implementation. It is, however, important that the school understand the vale of cross-curricular STEM at the school to maximise student opportunities.

Below are some scheduling suggestions based on observations from schools currently running SUBS in Schools.

1. After School as an Extra-Curricula Activity

Many schools run the program outside school hours as an extracurricular activity. A dedicated day every week where students can spend time in their team groups with supervision goes a long way. When it comes around to competitions, teams might need to spend more days after school or their lunchtime working on the project.

2. As an in-class activity

Many Schools will run the program within their teaching faculties. For example, a technology faculty might make one of their junior projects the SUBS in Schools program and all students in the cohort will form groups to design and build an ROV or submarine. The program has a natural fit as a cross-curricular teaching platform as it fits comfortably with Design, Art, Science and Maths. Cross-faculty collaboration however, can be challenging to achieve, but the benefits for the students are numerous.

For students to succeed in competitions being able to collaborate is an essential skill and a mandatory task. If they can work in an environment where they see teachers collaborating, it can be inspiring for the students. Students taking on the program do much better when they drive decision making via collaboration.

3. Running a dedicated subject

Running the program as a dedicated subject is something that has been taken up by many schools. Fortunately, some schools are moving away from the siloed style of education and recognise that showing the practical applications of STEM subjects benefits students when they go back into individual subject lessons. Cross-Curricular education can be a challenge and requires a broader school commitment to the program for timetabling.

Whichever the method of implementation, SUBS in Schools promotes and facilitates students engagement and collaboration with industry.

Fundamental Tasks - The basics

In the program, students form teams to produce a complete product which includes an ROV or Submarine outlining their processes for engineering and enterprise along the way.

1. Plan

Students form teams and assign roles to each member. Example team roles can include Design Engineer, Manufacturing Engineer, Project Manager, Team Manager, Resource Manager, Graphic Designer. There are no strict guidelines on roles and students should take ownership of delegating tasks and functions as they see fit.

2. Design & Analysis

Students use Computer-Aided Design (CAD) software to design an ROV or Submarine. CAD software allows analysis of the model's design via applications like Computational Fluid Dynamic (CFD) and Finite Element Analysis (FEA). These are tools regularly used by industry and will help students connect their efforts with real-world projects.

3. Make

Depending on the level and class of competition the students are attempting, they will either start with a kit or develop their own. In both cases students will have to add to the design, they can use off the shelf components or manufacture their own. Popular manufacturing options include 3D printing, CNC machining, laser cutting, silicone molds, vacuum forming and hand carving. In level 3 students build a virtual environment rather than a physcial product.

4. Testing & Sea Trials

Students put their underwater vehicles through a series of tests in a pool. Students must ensure that they stick to the rules and achieve all of the required tasks in a set amount of time.

Competition

Competition Levels

There are two levels or stepping stones of competition beyond an internal school competition. The following describes each of these steps.

1. State Finals

State Finals are organised by REA and are held during term three or four of each year. Teams must register to be eligible for this level of competition. Event schedules can be found on the REA website using this link:

https://rea.org.au/events-calendar-and-information/

2. National Finals

An REA organised event at which students from all over Australia gather to compete for the opportunity to represent Australia at an SUBS in Schools World Final. The level of the competition at an Australian National Final is close to the level of a World Final.

Does a school need to compete externally?

Entering external competitions is not critical in running the SUBS in Schools program. Internal school competitions may be as far as you would like to take the process initially as you build capability within the school.

Once students step above the in-school competition, they enter a very competitive international market. Competing outside of the school provides a platform where students have to operate outside their comfort zone. The number of competitors increases as does the quality of the competition. They can compare their progress against others outside their environment, which is no different from the real world where they will soon be competing for places at university and jobs. The better they can be prepared to take on the fierce competition, the better they will be able to make the transition to the world of work.

SUBS in Schools is the academic equivalent of team sports which provides an opportunity to undertake competition based on an academic pathway.

Students are required to adhere to strict rules and regulations, documented in two separate documents, the Technical Regulations and the Competition Regulations. These documents, while extensive, can be simplified for internal school competitions but should form the basis for implementing SUBS in Schools internally.

What's involved in competitions?

There are many levels and classes of competitions through which teams can progress. To participate in tournaments, teachers must first register the school via the REA website. There is **no cost** for a school to register. The registration process will allow REA to understand the communications protocol and points of contact within your school. It will enable REA to keep you briefed about upcoming competitions, public exposure events, government grants and opportunities for support and collaboration with industry.

Team registration is independent to school registration and is only for teams looking to compete in State, or National events. National final progression is dependent on performance in the State finals. The top teams progress based on performance with some wildcard opportunities offered to teams with the potential or capacity to step up and operate at a higher level.

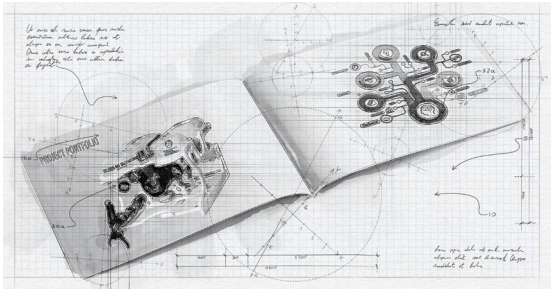
Competition Deliverables

There are several deliverables required for competition. An overview of these deliverables follows. The judging criteria for each of these deliverables are defined in rubrics contained in the Competition Regulations.

1. Portfolios

Students produce portfolios outlining both their Engineering and Enterprise processes, decisions and learnings. The production of high-quality folios is a critical component of the program. They should evidence a wide range of topics including career development, marketing, collaboration, project management, budgeting and engineering design and development.

Well produced portfolios have assisted students in gaining subject credits at university and be the differentiator in job applications.



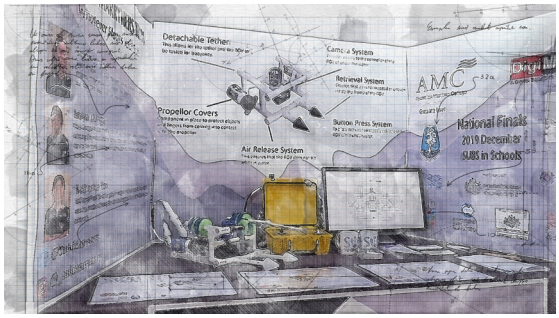
Technical & Competition Regulations

The SUBS in Schools competition requires competing teams to adhere to the regulations outlined in the official regulation documents. It's important that competing teams are aware of the competition & technical regulations and adhere to the rules outlined. The regulations can be found on the REA website using the following link - https://rea.org.au/SUBS-in-schools/resources/

There are two documents, the Technical Regulations and the Competition Regulations which can be found under the "Rules & Regulations" heading.

2. Trade Display

In the real world, many great ideas fall if not presented adequately to the audience. Students produce a trade display and marketing material designed to pitch their team to prospective sponsors and investors. Visual articulation via the trade booth also drives a critical reflection of their engineering processes as students sell their ideas and concepts to an outside audience. Trade booths should articulate details about the team, the process they followed, and provide an opportunity to deliver a return on investment (ROI) for sponsors and collaborators. They should be structured to captivate an onlooker who is not familiar with their project.



3. Verbal Presentation

Developing a capacity to communicate effectively is one of the two essential Life-Long STEM skills. The verbal presentation process provides a platform for students to develop these skills. Students deliver a 10-minute oral presentation where they get to tell the story of their team and their project to a panel of industry judges. They also cover the skills and passions they have discovered in themselves and how these relate to their career pathway.

4. Collaboration with Industry

Students are required to collaborate and partner with industry and outline how they achieved these in both their portfolio and oral presentation. Industry collaboration can involve a diverse range of interactions which could include Defence Industries, large Engineering firms, print shops, accountants, project managers, independent graphic designers and marketing professionals.

5. Finding sponsors and collaborators

To fund their project students are encouraged to collaborate with their community, a fundamental skill required for any entrepreneurial activity, but can be a challenge for students to undertake for the first time. Once mastered however, it can be highly rewarding when students succeed. Funding and budgeting is a vital part of the project, and the activities undertaken in this area should be highlighted in their portfolios and oral presentations.

Funding can come from industry sponsorship, simple fundraising activities, government grants or from the school's P&C.

6. Judging

Unique to SUBS in Schools is that judges from industry are used rather than teachers. Students often find they perform at a higher level, and grow as individuals when compelled to operate in a commercial environment. Industry judges contribute to student learning, providing direct feedback to the students in a way that matches the real world, helping prepare students for life after school.

7. Sea Trials

For the ROV & Submarine classes Sea Trials is where the excitement happens. The ROV's & SUBS have to perform a series of tasks in the pool within a time limit.

For the the Spatial design students they have to take the judges through a virtual walk through of their design using 3D goggles.

Implementation & Technology Requirements

Implementing SUBS in Schools can be easy and schools are likely to already have the resources required including:

3D CAD package

Students are required to design their ROV's & SUBS on a CAD package. Most schools will already have a CAD package being used by technology teachers and it is likely that will be adequate for SUBS in Schools.

A significant component of any product development process is the development of a 3D model. It is from a 3D model that many design decisions are made. A 3D model can also be a very useful component of the marketing process.

Access to 3D CAD/CAM software is a requirement for Levels 2, 3 & 4.

REA is able to extend our relationship with Dassault Systemes to provide schools with state of the art CATIA software through Dassault Systemes' 3D Experience Platform.

https://academy.3ds.com/en/challenges/3DEXPform

Software licenses are available for school networks as well as individual licenses for teacher and student personal computers.

An alternative for Schools who participate in Level 3 (Virtual design) is to use Sketch-up which is also available free to schools.

Sketch-Up is available for download from the following schools' web page. This website also provides curriculum materials and tutorials specifically designed for students and the classroom. Students will be able to download a version of Sketch-Up for use at home to help develop their skills.

https://www.sketchup.com/education/sketchup-for-schools

Access to Virtual Reality Software

Virtual Reality is a key component of Level 3. If schools would like to implement their own Virtual Reality (VR) environments REA can facilitate the equipment specification and access to software which would allow the school to undertake VR within the school.

The software system which is recommended for the students to use during the competition is IrisVR software available from the following web site.

https://irisvr.com/

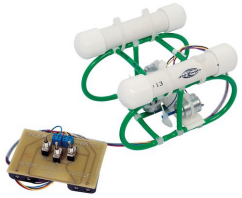
IrisVr offers a 45 day free trial and discounts of up to 90% for use by schools.

It is not a requirement of this challenge that students understand complexities behind the design of VR technology, only its use and application in the real world.

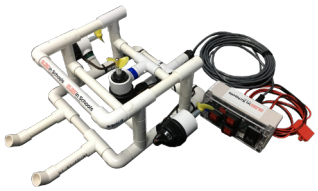
Available from Envizage

The kits required in levels 1, 2 and 4 can be purchased from www.envizage.com.au/subs-in-schools/ and are shown below.

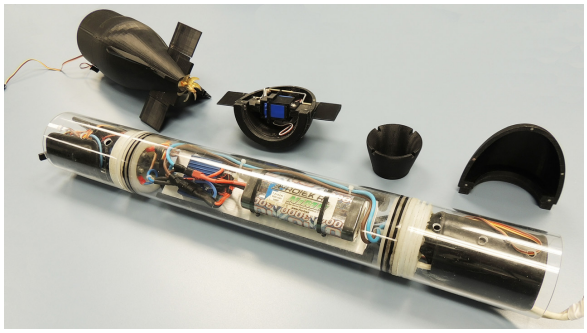
Level 1 - Mini ROV ($175)



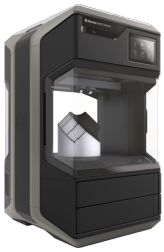
Level 2 - Development ROV ($550)



Level 4 - Submarine Kit ($1320)

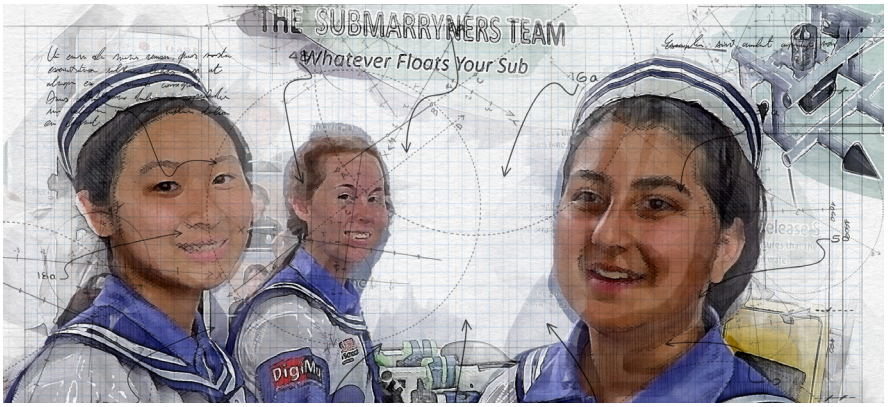


Through Envizage, REA is able to extend our partnership with Denford to offer CNC equipment and support to schools. Other STEM equipment such as MakerBot 3D printers are also availalbe.



Please contact our team for any product enquiries on

1300 204 478 or at info@envizage.com.au.



MORE INFORMATION

The following are sources of additional information:

REA Websites

www.rea.org.au

www.envizage.com.au

Youtube

youtube.com/c/ReEngineeringAustraliaFoundation

Above and Beyond Podcast Channel

Above and Beyond showcases stories of student success and the perspectives of teachers and industry toward STEM education and the relevance of *STEM in developing the skills industry is seeking.*

www.rea.org.au/above-and-beyond/

REA Research & Philosophy

Download the following documents from the REA website at:
www.rea.org.au/for-students-and-teachers/

- STEM 4.0 Life-Long Learning
- 2019 Educational Outcomes

NEXT STEPS

1. Schools should be to register on the REA website. This will notify REA of school interest and opens the line for communication.
2. Getting students on board and engaged with STEM at your school will involve having a schedule for STEM. If competing, the next stage would be to form teams and to then register teams on the REA website for competitions.
3. Be aware of deadlines and competition dates as well as the rules and regulations for the class they will be competing in.

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