in Schools
AUSTRALIA

STEM 4.0
LIFE-LONG
LEARNING

INTRODUCTORY OVERVIEW

An Introduction to F1 in Schools in Australia

Version 1.0

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An Initiative of
RE-ENGINEERING AUSTRALIA
FOUNDATION

AUTHORISED AGENT

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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.

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What is STEM

STEM in 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.

Programme Goals

F1 in Schools is based on Action Learning (AL) principles, which have an extended trajectory in terms of the involvement of the students and the outcomes that are achieved. 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 choices.

The goals of F1 in Schools are to:

- Bring career relevance to STEM learning activities,
- Excite and encourage students to consider careers and a learning pathway related to STEM,
- Provide an alternative learning and skills development in schools,
- Building employability skills in students which provide 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
- Develop skills in students which are directly transferable to industry roles in support of satisfying the skills requirement of large-scale Engineering programs.
- Facilitate technology transfer from industry to schools and the community at large,
- Raise STEM career opportunity awareness within schools and the wider community,
- Provide a catalyst for encouraging interaction and collaboration between schools, industry and the community,
- Encourage the collaboration between schools based in metropolitan environments with schools in country areas and internationally,
- Where appropriate, use the power of role models to guide and support our youth in the process of career development,
- Ensure that Science, Technology, Engineering and Mathematics becomes a part of the everyday language of students.

F1 in Schools is structured to allow teachers and students to develop their understanding of design and technology over time.

Background

The F1 in Schools program is founded on a STEM 4.0 philosophy which brings links to industry and real-world career relevance to 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.

F1 in Schools currently runs in 17,000 schools in 55 countries around the world.

The Excitement of F1 in Schools

Students participating in F1 in Schools follow the process of Design, Analyse, Make, Test, Race and Review as they create a miniature F1 race car. The journey for students is an iterative journey where they undertake research, come up with concept solutions and then manufacture and test their car. 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 or nation by representing Australia at an international F1 in Schools competition. The students can choose how far along the competition journey they would like to travel.

Designing an F1 car will require the formation of a team involving several students, all with different skills. As with a real F1 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 team.

Building skills in 3D modelling is an essential component of the initial design phase. It is crucial, however, for students to realise that F1 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 car design criteria before producing a viable design. They need to careful not to over-focus on one element of the process.

Students experienced with the process spilt the components of the design-manufacture-marketing process between team members early in the process and have selected a team manager early in the process. 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 F1 in Schools journey, the students will be able to look back and realise 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.

Implementation In School

Coordinating F1 in Schools at your school

F1 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 understands 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 F1 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 F1 in Schools program and all students in the cohort will form groups to design and build a car. 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 several 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, F1 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 a model F1 car 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 a model F1 car. CAD software allows analysis of the car'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:

Students manufacture their cars using a CNC router, bringing their models to life. Other manufacturing methods are also an option with many teams using 3D printing, carbon fibre, and different creative ways to produce the fastest car possible.

4. Testing & Racing:

Students race their cars on a 20m track powred by CO2 canisters reaching speeds of up to 80km/h. Racing is always fun for students, but to achieve a winning car in competition, students must ensure that they stick to the rules and limit car breakages through sound engineering.

Competition

Does a school need to compete externally?

Entering external competitions is not critical in running the F1 in Schools program. Internal school competitions may be as far as you would like to take the process initially as you build skills in the school.

Running this project in your school and using the resources does require schools to register at no cost. The School 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.

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.

F1 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 Rules. These documents, while extensive, can be simplified for internal school competitions but should form the basis for implementing F1 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 register their teams. Team Registration is independent to school registration and is only for teams looking to compete in State, National or International events. Some states will have regional competitions (currently NSW and Queensland) which are required before teams progress to State finals. Similarly, 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 setout within rubrics contained in the Australian Competition Regulations.

Technical & Competition Regulations

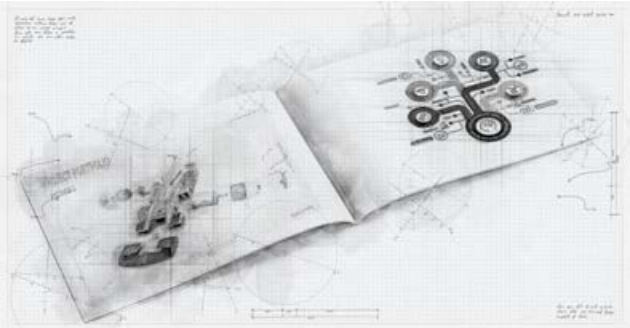
The F1 in Schools competition requires competing teams to adhere to the regulations outlined in the official regulation documents. It's important that competing teams area aware of the competition & technical regulations and adhere to the rules outlined. The regulations can be found on the REA website using the following link - https://rea.org.au/f1-in-schools/resources/

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

1. Portfolios:

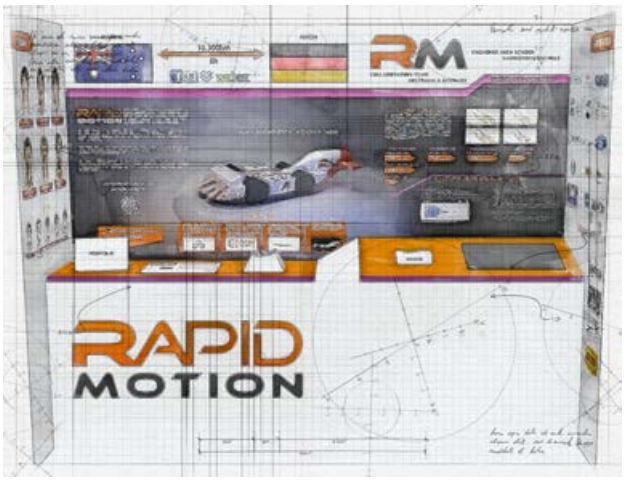
Students produce portfolios outlining both their Engineering and Enterprise processes, decisions and learnings. The production of high-quality folios is a critical component of the program. They should evidence a wide range of topics including career development, marketing, collaboration, project management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

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



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 and independent graphic designers.

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 F1 in Schools is that judges from industry are used where possible. 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. Racing

Racing is where the excitement happens. The cars initially race automatically to determine the pure performance, and then the teams come up against each other in manually running for the glory of success. Every race is as exciting as the 100m sprint final at the school carnival or the Olympics.

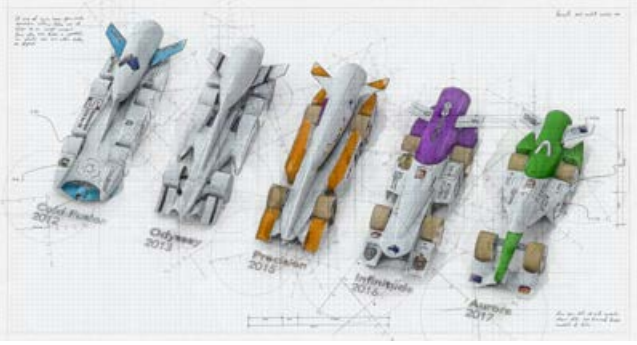
Classes of Competition

The competition is in three classes, from beginner to expert being Cadet Class, Development Class and Professional Class.

The Cadet class is for students who are new to F1 in Schools competitions and involves reduced rules and regulations as compared to the other classes. Restrictions exist for manufacturing the cars, they use standard REA wheels, and 3D printing is not permitted. This simplifies the design/build process for new students. Cadet class does not progress past the State level as students are not required to present portfolios, oral presentations or a trade display. Students produce a car, a poster outlining their work and an engineering compliance book only.

The Development class is for students in year nine or below. Students can only enter this class once and must be new to the program or only previously competed in the Cadet class. Some restrictions on this class include using standardised wheels, but 3D printing and other methods of production are permitted.

The Professional class is for students who have previously competed or are looking for a more significant challenge. This class is divided further into Junior Professional and Senior Professional based on student age. There aren't many restrictions in this class regarding manufacturing and innovation is encouraged.



Class-specific Rules and Requirements

The Australian Competition and Technical Tegulations outline the rules for each class. Competing teams must be made aware of the regulations documents and adhere to the rules and regulations for their class.

To access copies of these and other supporting documents go to: https://rea.org.au/f1-in-schools/resources/

Competition Levels

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

Regional Finals:

Managed by regional hub coordinators, these events are generally scheduled early to mid Term 3 and run in States with a high volumes of teams - generally NSW & QLD. Teams in these states **MUST** be registered for this first level of competition.

Details about regional coordinators is available on the REA website at:

https://rea.org.au/f1-in-schools/contacts/

State Finals:

State Finals are organised by REA and are held late in term three and early to mid term 4 each year. Teams must be registered 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/

National Final:

An REA organised event, students from all over Australia gather to compete for the opportunity to represent Australia at an F1 in Schools World Final. The level of the competition at an Australian National Final is close to the level of a World Final.

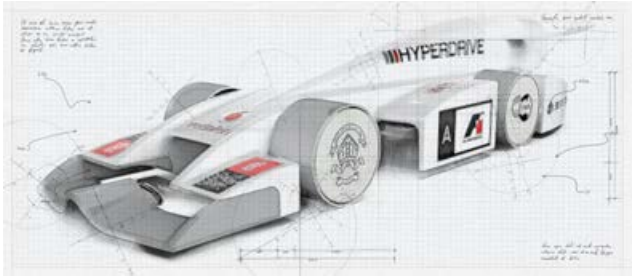
World Final:

Hosted by F1 in Schools International, this is the pinnacle competition where the best teams from 17,000 schools in 55 countries converge for a gala event. The winners are eligible for university scholarships, and top students have the opportunity to gain internships with F1 organisations.

The most recent events have been hosted in Singapore, Abu Dhabi and Austin, Texas. These events are a tremendous experience for both students and teachers.

Implementation & Technology Requirements

The technology required in a schools to implemet F1 in Schools is the following. Not all items are required to get started.



Access to CAD package:

Students are required to design their cars 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 F1 in Schools. 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.

To access this free software click on the following link and select F1 in Schools from the list.

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

CFD, FEA, PLM and simulation platforms are also accessible.

Access to CNC & 3D Printing Technologies:

In competitions it is a requirement for cars to be machined out of a block of Balsa wood using a CNC Router. It's possible that schools have an adequate router or can outsource the machining to another school or industry. REA is able to offer Denford CNC Equipment which is designed for schools and ideal for F1 in Schools.

Some classes of competition permit teams to 3D print components such as aerofoils, tetherguide support systems and wheels. Where 3D printing technologies are not available, alternatives such as carbon fibre can be used.

Consumables:

Balsa Blanks with pre-drilled canister chambers and tether guide slots from which car bodies **MUST** be machined, can be purchased from around $8 per block from REA.

Wheels Kits consisting of wheels, grommets, tether guides and brass axles can also be purchased through REA. These kits are manadatory for the Cadet & Development Classes. Professional class teams are permitted to make their own wheels but it can be very challenging.

CO2 Cannisters are also required to power the cars if the school has a track and cost less than $1 each.

A Race Track:

A track adds to the fun for students and is great to have on site for students to test and race their cars. It's not critical that school's have a track but it's highly recommended. Older tracks are compatible with F1 in Schools models and new tracks can be purchased from REA ranging from $6,000 to $13,000. Track hire is also available from REA.

A Smoke or Wind Tunnel:

Several new technologies are available for schools that can enhance the learning process. These include Smoke and Wind Tunnels which allow students to undertake visual analysis of the performance of the car designs. For more information these or other the other options contact REA.

Resources

Resources for the Challenge can be accessed via https://rea.org.au/f1-in-schools/resources/ and include:

- Technical Regulations
- Competition Regulations
- Supporting Documents
- Getting Started Document

REA staff are available to support teams and teachers.

Costs Summary

The funding required by schools to participate, will vary depending on the class of competition teams enter and the level they compete at.

There are generally no registration fees for competing at a Regional Final..

The following is an estimate of expense involved at each level of the competition.

1. Balsa Blanks
2. Wheel Kits
3. 3D printing for Development & Professional Classes
4. General Project Costs for printing portfolio and building a trade display
5. Team Registration Fees: At State and National Finals, REA will charge team participation fees. These fees will assist in funding the running of events including the provision of expo style booths for displays where relevant..
6. Competition Costs: Travel and accommodation costs associated with participating in any event. All travel and accommodation costs are the responsibility of teams and teachers.

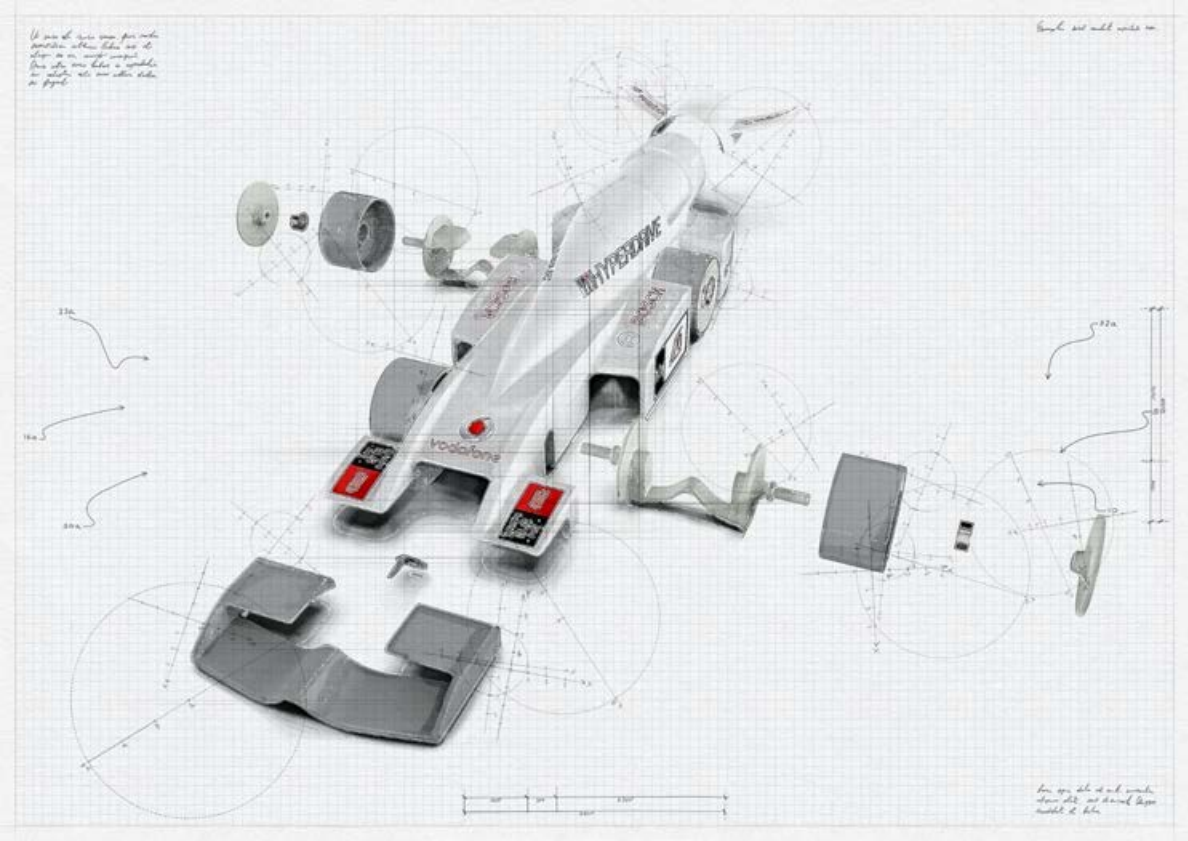
As part of the project's Marketing criteria, teams have the responsibility to raise sponsorship for **ALL** costs associated with participating in the Australian National Competition.

Calendar of Events

To access information on F1 in Schools events around Australia, go to: https://rea.org.au/events-calendar-and-information/

NEXT STEPS

1. Get students on board and engaged with STEM at your school - this will involve having a schedule for STEM and a Marketing plan in place to attract students to the project. There are lots of exciting videos you can access via REA's Youtube Channel
2. Read the 'Getting Started' document downloadable from https://rea.org.au/f1-in-schools/resources/
3. Schools delivering the F1 in Schools STEM Challenge regardless of whether they enter teams into the competition, **MUST** register on the REA website. This will notify REA of school interest and opens the line for communication. https://rea.org.au/f1-in-schools/fees-and-registration/
4. Read the Competition and Technical Regulations and provide copies to your students.. These are downloadable from https://rea.org.au/f1-in-schools/resources/
5. If competing, the next stage would be to form teams and to then register teams on the REA website for competitions. https://rea.org.au/f1-in-schools/fees-and-registration/
6. Be aware of deadlines and competition dates. https://rea.org.au/events-calendar-and-information/
7. Call REA if you need any support.



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

Download the following documents from the REA website:

- STEM 4.0 Life-Long Learning
- 2019 Educational outcomes

www.rea.org.au/for-students-and-teachers/

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