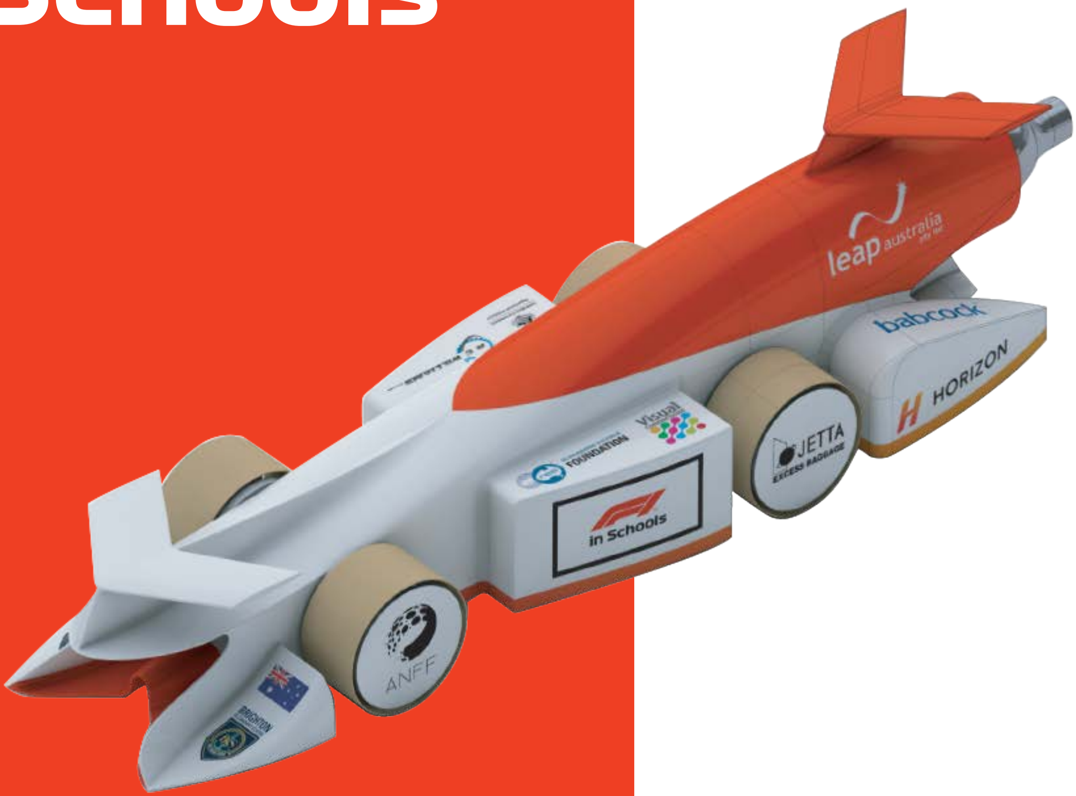
F1™ in Schools

RE-ENGINEERING AUSTRALIA FOUNDATION



GETTING STARTED

A guide to running F1 in Schools in Australia

Version 1.0

Re-Engineering Australia Foundation Ltd
U7, 20-22 Foundry Road
Seven Hills NSW 2147

1 300 204 476
(02) 9620 9944

www.rea.org.au
www.envizage.com.au

AUTHORISED AGENT

Re-Engineering Australia Foundation Ltd.
PO Box 136
Castle Hill NSW 1765

P: 61 2 9620 9944

F: 61 2 8079 0622

E: contact@rea.org.au
W: www.rea.org.au

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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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1. Introduction

The F1 in Schools STEM Challenge provides an exciting and engaging experience for students through the captivating appeal of Formula 1. Through the challenge, teams of students use Computer Aided Design (CAD) to design, analyse, manufacture, test and race model F1 cars manufactured from a block of balsa wood. The cars race on a 20m track powered by CO2 canisters and reach speeds of up to 80km/h.

The program allows students to learn about physics, aerodynamics, design processes, manufacturing, marketing, graphics, sponsorship, teamwork, communication, media, careers, finance and to bring all of these together practically and creatively to compete with their peers.

F1 in Schools is operational in 13,000 schools in 51 countries around the world. Students start off competing with their peers at school and can take the journey of discovery across the globe. Regardless of how the program runs, it allows students to develop and bring together a range of STEM concepts and apply them to a practical, wide-ranging project.

2. Brief Outline

Key Learnings

Schools running the program can create a set of internal rules and regulations but to compete outside of the school student teams must adhere to the Australian Technical and Competition regulations. The following are the key learning areas for students participating in F1 in Schools.

- Teamwork: Students form a team of 3–5 members, develop a team name and assign roles and responsibilities within their team i.e. Team Manager, Manufacturing Engineer, Design Engineer, Graphic Designer and Resource Manager.
- Collaboration: Teams are encouraged to collaborate with industry to seek mentors and create business links which will help them develop an understanding of potential career pathways that align with their skills and motivations.
- Business and Sponsorship: Students plan and prepare a business plan, develop a budget and through collaboration with industry, raise sponsorship to fund their team. Having to raise funding to support their own team's activities helps the students gain an understanding of what it takes to build and fund a business and become entrepreneurs.
- Design: Using 3D Computer-Aided Design (CAD) software, students design their car to a set of specifications outlined in the Technical Regulations, just like in the real Formula 1. They have the opportunity to use the same technology as used in industry by companies such as BOEING, Toyota & Tesla.
- Analyse: Students use a range of computational and non-computational tools to help them examine areas such as strength and aerodynamics. Computational Fluid Dynamics (CFD) software allows them to analyse drag coefficients in a virtual wind tunnel. Finite Element Analysis (FEA) will enable students to analyse the structural performance of their cars.
- Test: Students can use a smoke tunnel or wind tunnel to cross corollate computational aerodynamic results in wind and smoke tunnels. Students can also physically race their car to test the robustness of design, the accuracy of their manufacturing, wheel alignment and any other aspects they feel might influence their car's performance.
- Make: Students turn their 3D design into reality utilising 3D Computer Aided Manufacture (CAM) software, along the way evaluating the most efficient machining strategy to make the car and taking note of any issues they faced.

Technical & Competition Regulations

The F1 in Schools competition requires competing teams to adhere to the regulations outlined in the official Australian competition documents. Competing teams must be aware of and comply with the competition & technical regulations. These 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 available under the "Rules & Regulations" heading.

Competition Deliverables

The competition element of F1 in Schools allows students to maximise their learning potential in an environment where they have the opportunity to interface with people from industry and gain a positioning of their knowledge against the expectations they will be facing when they move to the world of work.

Industry judges assess student work in the following areas:

- Scrutineering: The cars must comply with a strict set of rules and regulations similar to what they would face in any industry. Cars enter 'Parc Fermé where the judges measure every dimension to ensure they comply with the Technical Regulations.
- Engineering: Students take judges through the processes and methodologies they used to design their car. They interact with mentors from industry, sharing knowledge and experience.
- Project Portfolio: Students are required to produce an A3 project portfolio in two parts: an enterprise portfolio, documenting the business and marketing components of the project, and an engineering portfolio which documents the design, manufacturing and testing of their car.
- Trade Display: To help build an understanding of the importance of marketing and communication, students create an informative display showing their work through all stages of the project, their team identity, marketing and management and present their display to a panel of judges.
- Verbal Presentation: Students prepare and deliver a presentation to a panel of judges focussing on collaboration, innovation and career development, which assists in building communications skills, self-confidence and self-efficacy.
- Racing: This is where the students test their designs and examine analytically what they may need to do to improve performance and reduce the time it takes to cover the 20m track.

Competition is at several levels in Australia. Schools can run internal tournaments, and teams can go on to take part in Regional, State, National and International competitions. Australia has a fantastic record on the World Finals stage. We are proud of our Aussie students and what they have accomplished across the globe in the F1 in Schools Competition.

Horizon, Brighton Secondary School, SA
World Champions, 2018 F1 in Schools World Final, Singapore

WORLD CHAMPIONS

2006 2011 2012 2013 2017 2018

3. Minimum Requirements

School Computers with CAD software

It is a requirement for students to use 3D software when designing their cars. There is a range of free CAD software currently available to schools. REA is offering free access to Dassault Systems 3D Experience software which includes apps for 3D Design, Computational Analysis, Project Management, Document management and collaboration. To access 3D Experience, schools must first register on the REA website and then with Dassault Systemes.

We encourage schools to use 3D Experience software, the same software used by BOEING, Toyota, Tesla and the Australian Future Submarine project. It will facilitate students developing skills in these areas which can translate directly into careers in industry, facilitating Life-Long STEM Learning. Schools who already have experience with CAD software will find the transition quite easy.

Access to a CNC Machine

The competition requires students to design a CAD model of their F1 car and then create a 3D model using a CNC Router. REA can supply Denford CNC routers to schools which are ideal for F1 in Schools.

Schools without their own CNC Router are still able to produce a model car by outsourcing their vehicle manufacture. In most cases, schools can source CNC manufacture at reasonable or no cost via relationships with other local schools, TAFEs, universities and industries.

Different classes of competition have different rules regarding the manufacturing process. Teams need to check the rules and regulations to ensure they adhere to the manufacturing regulations for their level of competition. Competition classes will be discussed in more detail later in this document.

Higher levels of competition also may require students to 3D print components of their car (such as the front and rear wing). If schools are going to invest in a 3D-printer, our recommendation would be to invest in a robust 3D printer rather than a cheaper printer which can sometimes be challenging to manage and maintain and produce an inferior outcome.

Note: 3D printing is not a requirement of the program. Some alternatives to 3D printing include CNC machining and using carbon fibre.

Consumables

Cars are manufactured from a block of Balsa which are available from $7.20 - $7.80 each from REA's ENVIZAGE website. Standard REA wheel kits (required when participating in the Cadet and Development Classes of competition) are available for $4.50 a set and can be reused on different cars. The CO2 canisters which power the cars are available at a cost less than $1 each but unfortunately cannot be reused.

Racing

A race track is ideal for adding to the fun of the program for students. The official Denford F1 in Schools Race Tracks are also available from Envizage. If a school would like to purchase a race track, there are several options for race tracks ranging from around $6000 for a basic track to $13,000 for the top of the range track as used in State National and international events. Often used race tracks also become available at a reduced cost.

It is not critical that a school has a track to run the program or compete. Depending on the location, schools may be able to borrow a race track from a nearby school. Alternatively, race tracks are available for hire on race days. REA offers for hire an elevated competition race track for $600 (ex GST) plus a cost for each additional day on-site. Floor mounted roll-out track hire is also an option for $500 per week plus shipping. Hire is subject to availability and long-term hire is not available.

Equipment Purchase - www.envizage.com.au

Through its ENVIZAGE website, REA provides access to consumables and Denford CNC equipment as well as a range of other STEM project consumables.

Denford CNC equipment has been designed for use in school environments.

4. Implementation

Running the program at your school

F1 in Schools is student-centred, and it's up to the students to plan and develop their ideas. The role of the teachers is one of coach and facilitator. the challenge being the time required to devote to assisting students. If you're reading this document, then it's very likely you have what is needed to take on F1 in Schools at your school.

Schools run the program in a variety of ways. Some will run F1 in Schools outside school hours as an extra-curricular activity. Many others run the program as a part of their curriculum, integrating it into Design and Technology, Science classes or in dedicated Engineering. STEM or "F1 in Schools" elective classes. There is no ideal way to run the program, but you should consider what is most practical and sustainable in your school's context. It might take some trial and error to find what works best.

Teachers who consistently do well in the program guide their teams and poke and prod them in the right direction. It's not a program especially designed around specific material or work plans but rather an open-ended approach to exploring knowledge to determine how it fits within an analytical problem-solving environment. While F1 in Schools provides the flexibility required to help students develop and refine their ideas, access to a wealth of knowledge and training material is made available to teachers around which they can structure classes.

Working knowledge of CAD design or access to staff members with these skills is an excellent pre-requisite for running the program successfully. While CNC machining and 3D printing can be outsourced, it is an advantage if students have hands-on experience of the manufacturing process and leverage the knowledge of teachers at the school.

Scheduling Suggestions

Teachers should use their professional judgement to decide how the program should operate within a school as every environment is different. With an understanding of the school's context and by gauging the broader support from other staff and faculties, STEM teachers (regardless of faculty) should think of implementing F1 in Schools in a way that will work for their students at their school. Below are some suggestions based on observations from schools currently running F1 in Schools.

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.

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.

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.

Note: The WA School Curriculum and Standards Authority has endorsed REA's F1 in Schools STEM Challenge and students completing this program from 2020 can count this learning towards their Western Australian Certificate of Education (WACE) and have the achievement reported on their WA Statement of Students Achievement .

5. Student & School Outcomes

Student Outcomes

Students who participate in the program come out the other side very different. There are a range of tangible learning outcomes that students can achieve, but these are secondary to building character and opening their minds to the possibilities in the world around them. The REA website contains numerous stories of student success.

Through our competitions, students interact with industry mentors and learn about STEM concepts but equally as important, students learn about themselves, their strengths and weaknesses and are encouraged to grow as individuals. Students are motivated to move out of their comfort zone and delve into the unknown.

In addition to increased understanding of technical concepts, students:

- Build confidence and develop interpersonal skills,
- Develop an understanding of the design and manufacturing process which produces much of what they interact with daily,
- Develop an understanding of different careers and job opportunities available beyond school,
- Bring together concepts which are generally taught in siloed lessons and produce a finished product they can touch and feel,
- Are given an opportunity to network with industry and their peers beyond the walls of their school.

School Outcomes

Schools that participate in F1 in Schools can say with confidence that they are implementing a tried-and-tested STEM learning program. Participating in F1 in Schools offers an opportunity for students to represent their school on a state, national and international stage.

All-encompassing STEM programs are challenging to find, and F1 in Schools covers many bases that one would hope are already present in a school's plan. At a time where schools are required to demonstrate their active involvement in broadening their student's understanding of STEM and careers, the F1 in Schools program is a great solution.

School benefits include:

- Local industry interaction and support,
- Engagement with other schools and educational institutions including feeder schools and tertiary institutions,
- Publicity in their local community as well as the opportunity to be represented on a state, national and international level,
- Development of career-focused and well-equipped students,
- The provision of educational and career-advancing opportunities for staff,
- Increased confidence of parents by providing proven educational programs which prepare students for the world of work,
- Collaboration between faculties to highlight student achievement,
- Engagement for academically disengaged students,
- Providing an open-ended, limitless project for high-performing students.

"F1 in Schools is the foundation and key innovation focus in our STEM program. It's taught as a curriculum subject with some 150 students taking part each year. Teachers in all subject disciplines contribute to the program, promoting true STEM ideals."

Stephen Read: Lead STEM teacher, Brighton Secondary School

6. Changing Perspectives

Changing Attitudes in Students and Teachers

Over the past 14 years, REA has been undertaking a longitudinal research project into the Motivational Drivers of Childrens Career Decision Choices and the effectiveness of its programs. We use this research to continually modify our approach to engaging students.

Whilst our alumni have gone on to take up careers as diverse as becoming orthopaedic surgeons to engineers in companies like AIRBUS, changing student and teacher attitudes towards education is as much of an achievement as individual success stories.

We have always looked to foster an attitude of learning and growth within both students and teachers. We do this by putting much effort into our planning and events - allowing opportunities for our industry-based judges to interact with staff and students who attend. Networking and peer-learning are just some of the ways we look to facilitate growth.

Anecdotally we have seen teachers completely shift in their attitude towards education through engaging in our programs. We're proud that we can reach the people in charge of creating Australia's future.

Disengaged Students

At REA, we are continually hearing success stories from participating schools on how the program has influenced students. It's great to allow top students to achieve without a ceiling, but re-engaging students who have written off schooling is equally as important. Samantha White from Picton High School in NSW is a great success story from F1 in Schools. In year 9, Samantha was disengaged, disruptive in class and had many school visits from her parents to discuss her unruly behaviour. Through participating in F1 in Schools, Samantha was able to re-engage with schooling. In her own words she revealed that her subjects didn't appeal to her, and she lacked direction. After competing, she had a complete shift in attitude...

"I didn't realise the F1 program was such hard work. But I really loved the learning. I got to use CATIA software, produce G-code, and design and make our race cars."

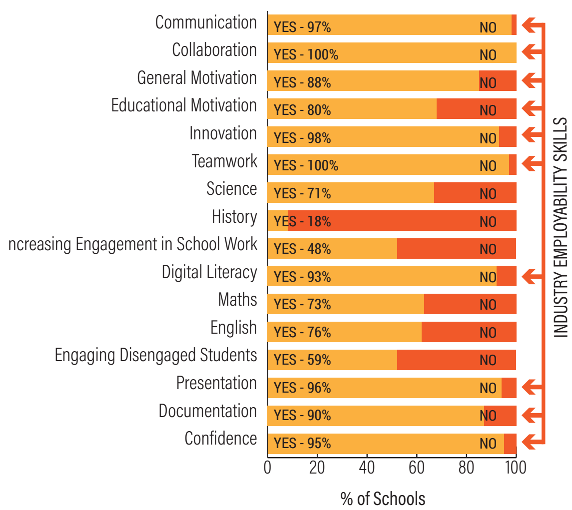
Samantha White: Manufacturing Engineer & NSW State Champion

Building on from her F1 in Schools journey, Samantha was able to re-engage with school and ended up going on to study HSC-level physics in year 10. Her teacher at the time, Tony Lane, elaborates on her improvement during and after the competition.

"This program has made all the difference. She is [now] a model student who is excelling in her subjects."

Another school in rural NSW told a story of a student who was struggling with attendance and barely went to school until they had decided to take on F1 in Schools. That student's attendance increased, showing that they were at school on days that coincided precisely with the days the school ran the F1 in Schools program. We have many stories we can share about students re-engaging with schooling as a result of their involvement in our programs. More data taken from REA's first-hand research is available in our Educational Outcomes Report.

In Which Subject Areas Have You Seen a Visible Improvement in Student Performance as a Result of Their Participation in REA Programs:



Educational Outcomes Report

REA is consistently chasing up feedback and data from students and staff participating in REA programs. Our Educational Outcomes Report displays data acquired over many years of research into STEM and education. The full report can be found under the "Education Outcomes Research" heading using the link below.

https://rea.org.au/for-students-and-teachers/

7. F1 in Schools Levels

F1 in Schools Primary STEM Project

This program engages students from as young as five in building and racing a paper-based F1 car on a full-sized F1 in Schools track or a more affordable roll out track. Cars can be powered by an air-pump system or CO2 canisters reaching speeds of 80kph. This STEM project is excellent for students in primary school or early high school years Students can gain an introductory level understanding from this easy-to-run school-based activity

Many high schools involved in F1 in Schools use the Primary STEM Project as a means of engaging with their feeder primay schools and run it as a challenge.

Comes with a range of teacher resources.

F1 in Schools (non-competitive)

Schools can run F1 in Schools internally without entering competitions. Depending on how developed a school's STEM program is, this might be an excellent place to start. Schools that don't compete should still use the REA competition rules and regulations as a template for their program to guide students through the same process as competing teams. We do ask that all schools delivering this project regardless of whether entering teams into the competition, register for free on the REA website.

F1 in Schools - Australian Competition

F1 in Schools is a multi-faceted and multi-disciplinary program based on the design and manufacture of miniature F1 cars. It facilitates student collaboration with industry partners within the context of their projects to learn about STEM principles and careers. This program is excellent for all high school years as well as high-achieving primary students. In Australia, the program has three classes based on age and experience.

Cadet Class (1-3 members)

Cadet Class is an entry-level class for students split into two divisions - Junior (Years 5 - 9) and Senior (Years 10 - 12). Students can only compete in this class once. The simplified submission requirements require a student to produce only one car, a poster and an engineering drawing. Some restrictions include the entire car body and aerofoils machined out of balsa wood only using mirrored side machining with no 3D printing permitted and using the REA kit wheels.

Development Class (3-5 members)

This class is also an entry-level class for students who have never previously competed or only previously competed in the Cadet Class. Students can only compete in this class once and must be in years five through nine. In the Development Class, the car body and rear aerofoil must be machined from balsa only but teams are permitted to have a 3D printed front aerofoil. There are still some restrictions in this class to simplify the machining process for manufacture, using REA kit wheels and a reduced portfolio and trade display, but teams must address all of the judging criteria.

Professional Class (3-5 members)

The highest level of Australian competition students can achieve. There are no machining restrictions and students can develop their own wheels and wheel systems. Teams are permitted to manufacture their front and rear aerofoils using an alternative non metallic material. This class permits teams to demonstrate high levels of innovation. The Professional Class has both a junior (Year 5 - 9) and senior (Years 10 - 12) division. If any student in a team is in year 10 or above the team must enter the senior division. Students can enter mulitiple times in this class so long as they meet the age eligibility requirements. Teams must address all of the judging criteria.

8. Stepping Stones

F1 in Schools Level		Brief overview and a look at student learnings
Primary STEM Project (air-pump or CO2 powered paper cars)	K-6	Students in years K - 2 learn the basics of what's involved in F1 in Schools. This level is excellent for STEM days, introducing new concepts to students and is very fun. Students can consider STEM concepts around the physics of the moving car, including friction, air resistance, drag, measurement and air pressure, all promoting their analytical problem-solving ability Paper cars launched on a track equates to noise and speed, engaging students, allowing for more excitement and competition. Students in years 3 - 6 can move to the next level, learning about time, speed calculations, aerofoils and touch on design and manufacture. Students start the process of doing their own research at this level. .
F1 in Schools (non-competitive)	5-12	Schools are able to adapt F1 in Schools into their own STEM program as they wish. The learning outcomes and guidelines can be determined by schools internally and we encourage basing these off REA official regulations. Non-competing schools are still required to register on the REA website and REA is able to support non-competing schools on their STEM journey. Learning outcomes will be similar to those listed in the competitive classes below.
Cadet Class (Junior)	5-9	Students create a simple car using balsa wood and REA kit wheels only (no 3D printing). Students are required to conduct their research and present their overall project results and findings in a poster. They learn about the design process, manufacturing, tolerance, testing and mass and are required to justify their methods and improvements. At this level, students must develop a knowledge and application of CAD and deliver an A3 engineering compliance drawing of their final CAD model. design.
Development Class	5-9	Students develop a slightly more complex F1 in Schools car which can incorporate 3D printed components (while not a requirement). At this level, students further develop their understanding of enterprise and what's involved in a large project. Students must develop and demonstrate a good understanding of CAD and CFD as well as producing evidence of their design process and design decisions and an understanding of scientific principles (such as Bernoulli's principle) in an engineering portfolio. In addition to their research into STEM concepts, students have to demonstrate an understanding of project management, marketing, finance and careers, deliver a verbal presentation and a reduced trade display...
Professional Class (Junior)	5-9	Requires a more significant commitment from students as they work on producing two portfolios slightly longer and more detailed than that of the development class and a full trade display. Students are required to undertake more extensive industry collaboration and document their design and decision-making processes. Students have no restrictions when it comes to manufacturing, and innovation in any area of the competition (whether in engineering or enterprise) is rewarded through the judging process.
Cadet Class (senior)	10-12	The requirements for the senior cadet class are the same as those for the Junior Cadet. Students in years 10-12 attempting F1 in Schools for the first time are permitted to enter this class. In most cases, we encourage senior students to enter the professional class.
Professional Class (Senior)	10-12	The Professional senior class has the same requirements as the junior class but is for older students. If any student in a team is in year ten or above and looking for a more significant challenge than the Cadet class, they must enter the senior professional level.

More on Learning Outcomes

Quantifying all outcomes achieved by the program is challenging. There are some STEM concepts which students must cover, such as CAD design, design processes, testing, analysis and manufacturing; however, the program is open-ended, and innovation is encouraged.

School's have run seminars on more profound concepts such as Bernoulli's Principle or aerodynamics, but learning about these concepts, and including them in final submission is up to each team. Students may find they want to go in an unconventional route and dive into different ideas - perhaps in areas such as statistics or coding.

Students take ownership of their learning and collaborate with industry to secure their futures at an early age.

9. Primary School Options

The F1 in Schools program has many points of entry to accommodate school needs. Built into F1 in Schools is an understanding that learning happens over time, and through the application of knowledge. While the lower levels of F1 in Schools fit with primary schools, they can be a gauge for determining student interest in early high school years. They can also form a platform to connect high schools with primary feeder schools.

The program facilitates ongoing learning for both staff and students as the program develops within a school's context. It has been the consistent and incremental progress that has taken place in Australian schools, that is behind Australia's success on the world stage.

Primary Years/Early Engagement

Paper cars are an entry-level to the program for primary students and for schools that want to see how their students respond to the concepts involved within the program. With paper cars, there are a couple of different options which are described in more detail below. These two options below can be a good starting point for primary students or high schools looking to engage local primary schools. The official F1 in Schools competition has limited opportunities for primary school students, but it's a great place to start. Primary students can enter higher levels of competition if they wish.

Air-Pump Powered Launch System

The air-pump powered launch system and roll-out track is a fun and safe activity to get younger students engaged with STEM involving students putting together a foldable car. The guidelines are no more complicated than a paper aeroplane. Students use the pump mechanism to increase pressure and hit a big "go" button to launch the cars.

Students have fun using the track and have the opportunity to learn about many STEM aspects such as air pressure, speed, friction, aerodynamics, units of measurement, mass and drag.

Teacher resources produced by Denford and further information can be found at www.primarystemproject.com or by contacting REA.

Paper Racers/Primary School STEM Project

Using paper cars on a full-size or roll-out track is a great way to get students involved in STEM. The paper racers can be used for primary "STEM" days and for students trying to get an understanding of the larger F1 in Schools program.

The paper racers are designed for use with CO2 canisters and reach high speeds but not quite as fast as cars machined out of balsa.

Students can customise their cars and can learn a lot about STEM-related concepts. Students at a slightly higher level can incorporate the same learning as they would for the pump-up launch system but with the addition of an understanding of safety, time calculations and reaction time. In addition to customising the look of the car, students may experiment with tape to see how directing airflow can affect the vehicle's speed.

The cars use affordable standard REA wheels and axles as well as foldable paper templates.

Simple paper cars on air-pump track

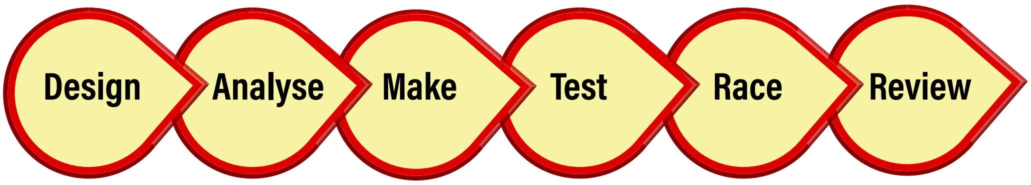
More complex paper cars on a full-size track

10. The F1 in Schools Process

The process which students follow is: design, analyse, make, test, race and review.

Over time the process relies on the students learning from each other, from teachers and former competitors. The classroom becomes an environment where knowledge is shared between students and across teams as an ideal way to ensure students get the most out of the program.

Throughout the process, described in the following pages, students will continuously be making improvements. Perhaps they will need to cycle through the design to review process a few times before they get the hang of it.



On the first attempt, students might be still figuring out how CAD works. A few tries later, the CAD functionality will become second nature, and perhaps they will be able to improve on other aspects of the competition. Overall, the F1 in Schools program is designed to be a learning process. As students work through each competition level, they will find that they have spent many hundreds of hours on the project, and by the end they should have produced a range of quality material to look back on and also to call on if required in a job or tertiary study interview.

Allowing students to see their own progress through the program is excellent for building their confidence and understanding of how projects work in the real world and how what they learn at school can be applied to the world outside of school.

The F1 in Schools program differentiates for your students using the 'class structure' for competitions. Students will come from different backgrounds and may come with some level of prior knowledge. It's essential for staff to recognise student level and allow students to grow and progress at their own pace.

Each step in the design, analyse, make, test, review process is discussed in the following pages. Some aspects are only relevant to specific classes, but generally, the concepts involved will also work for teams that aren't competing at all. Elements such as trade booths are only relevant to competing teams, and even then, are only applicable to specific classes of competing teams. For new schools, determining student classes is something that can be decided after students start developing a foundation of understanding.

It's essential to keep in mind that the competition has comprehensive rules and regulations which competing teams must adhere to. There are technical regulations and competition regulations described in slightly more detail below and available on the REA website. If running an internal competition, schools are encouraged to use REA regulations as a template for simplified judging criteria. Students might design a few cars before deciding they will compete and move on to other aspects of the competition, such as trade booths and portfolios.

Regulation Documents

There are two regulations documents. The Technical Regulations relate to the specifications required for the car design and manufacture. There are different rules for different classes, so teams must read the regulations well and are familiar with what is permitted.

Competition Regulations contain information about the competition itself. It includes information on team membership, compliance with competition process, submitting project elements for judging, racing and car repair regulations, as well as information on all of the assessible criteria such as CAD, manufacturing, portfolios, marketing and verbal presentations, including access to all of the scorecards by which teams are assessed.

Critical Regulations

Critical Regulations appear in the Technical Regulations document. Failing to adhere to the Critical Regulations will incur hard-hitting time penalties (as well as point penalties). The Critical Regulations are indicated with a yellow exclamation mark.

11. Design

Car Design and CAD package selection

Students must develop an understanding of CAD software. Initially, when designing cars, students should be given a walkthrough of the particular CAD package used at the school and directed to tutorial videos if necessary.

There are a range of CAD packages suitable for F1 in Schools. REA recommends using Dassault Systemes 3DExperience platform, which is available for free to schools registered for REA programs. Other CAD packages include but aren't limited to Solidworks, Autodesk's Inventor & Fusion 360. If staff are already familiar with a particular CAD package then that is the best to use if new to F1 in Schools.

On the REA website, students can find CAD models for the wheel kits and balsa blanks, saving the students having to design these elements. There is also a range of online resources and videos which step students through the process of modelling and F1 in Schools car - The Dassault Systemes platform has built-in tutorials and other packages have relevant YouTube videos which can guide students through the process. Assistance from teachers familiar with CAD will be beneficial in the early stages of designing.

Technical Regulations

Teams entering competitions must consider the "Australian Technical Regulations" document when designing their cars. Teams may miss critical information, which will lead to penalties during the event. While this is a warning for new teams, experienced teams will often also make errors when students are careless or feel that they're beyond checking the regulations against their design and final model.

Ensure students take note of the critical regulations which attract a time penalty. The first steps in designing for new teams would be to consider which CAD package is most suitable to use within the school context. If competing, then teams should also be given (or directed to) the official REA F1 in Schools Technical Regulations - these are updated year-to-year, and it's good practice to consider the Technical Regulations early on in the design process.

Example Technical Regulation

This example shows the requirements of the designed car's wheels and body. Scrutineers will measure the car and if in violation, the team will lose points and, in this case, incur a time penalty. The yellow triangle indicates that this is a critical regulation. Cars deemed unsafe, or that fail some critical rules won't be allowed to race until brought into compliance. The Specifications Scorecard that scrutineer judges use is available in the competition regulations document.

T7.9 Visibility from Top, Bottom & Side **[0.05 Time Penalty | 4 Pt Penalty]**

The view of the wheels **MUST NOT** be obscured in any way, by any component of the car, in the car's top, bottom and side elevation views. A minimum of a 1mm vertical exclusion zone **MUST** be present in front of each wheel and behind each rear wheel and in the top view, the track surface **MUST** be visible immediately in front and behind the wheel width.

Parc-Ferme/Scrutineering/Rectification/Repairs

In competitions, cars are submitted into Parc-Ferme for scrutineering before any racing takes place. The scrutineers will ensure that each car is compliant with the technical regulations and teams will be penalised for any errors either through a point penalty or a time penalty or both. Teams will have an opportunity to rectify violations of critical regulations only, and unsafe cars will not be permitted to race until they are made safe. It's essential for competing teams to make sure their cars comply with the regulations and that they have access to current versions of the official REA Technical and Competition regulations.

Students are required to submit an engineering compliance booklet in addition to their enterprise and engineering portfolios which will also be assessed by judges.

During racing, if a car breaks, students are given time to make repairs, so it's essential to consider the design of the car is robust and capable of enduring the 'collision' with a de-acceleration system at the track finish. Cars that break often will likely lose some performance and cars that break beyond repair will not race, resulting in a loss of points.

12. Analysis &Testing

Testing can be conducted in many ways and doesn't need to be complicated. For example, students can roll their finished product on a flat surface to see if the wheels are well aligned. They can also use simple measurements of the components of the car to test the accuracy of the manufacturing and finishing process.

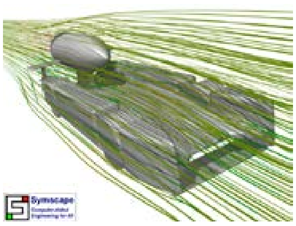
While testing can be simple, it should be documented in student workbooks and engineering portfolios with explanations of how improvements were achieved and how ideas were built upon throughout the process of designing, analysing, manufacturing and testing.

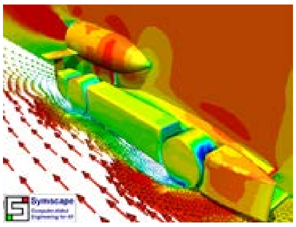
Computational fluid dynamics (CFD) analysis is a great place to start when it comes to analysing a design before going to manufacture. Finite element analysis (FEA) is also possible on most CAD packages which identify the forces acting on a particular model. Students can discover a lot about their car and design both before and after manufacturing their car.

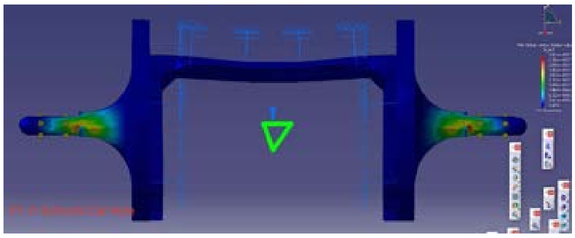
Further to CFD and FEA, students can use equipment such as smoke tunnels to gain a better understanding of airflow and aerodynamics. Smoke Tunnels are a great way to visualise the flow of air around their car and how different designs can affect airflow. Considering things like frontal surface area and air turbulence are very much applicable to many engineered solutions they come across in daily life.

The Air Trace smoke visualisation system is an excellent way for teams to see how air flows around their finished product. The system is great for comparing different shaped vehicles and can be incorporated into a larger lesson on aerodynamics, engineering and design.

Examples of FEA and CFD analysis







Virtual Wind Tunnel

REA can offer Virtual Wind Tunnel (VWT) software. The easy-to-use software accepts an STL file and will give students a good idea of how effective their car will be when manoeuvering at high speeds. Using software such as this can very efficiently point out flaws in a design before the manufacturing process. Students must consider the cost of production in their plans and manufacture designs which they already feel will produce a robust and fast car.

Testing vs. Analysis

While the process of F1 in Schools is built on design, analyse, make, test, race and review, there is a clear relationship between testing and analysing. The question of when to go to manufacture should be decided as a group after students feel enough virtual analysis has taken place. There is no point in producing a car that is expected to have poor results.

At the same time, analysis can be confusing and inaccurate. Using computer simulations has many advantages but also some shortfalls. It's up to teams to find the right balance between resource allocation and data acquisition. There is much learning students can glean out of this process - comparing modelled results to what happens in the real world can be an excellent way to validate the effectiveness of individual components.

Track Testing

Students will eventually need to race their car on a track. This will be the true test of a car's speed. Having a track available for students will be valuable as they determine which design changes are effective and which are not.

13. Manufacture

Machining

Machining requires the use of a CNC Router. The process of machining a car from a block gives students an excellent understanding of the manufacturing process.

In the professional class, teams may also wish to machine their wheels on a CNC which generally achieves a much better result than using 3D printing for this purpose.

It's best if students have access to a router to get a hands-on experience of the process. However, if students don't have access, it's possible to outsource the machining to nearby industry, schools, TAFEs or universities. Please contact REA if you need a hand sourcing a router.

3D Printing & Additive Manufacturing

Components of the car can be 3D printed such as the front and rear wings. In the professional class, wheels can also be 3D printed, but in the cadet class, 3D printing is not allowed.

When competing, it's essential to check the your finished design complies with the regulations. While 3D printing may be allowed in certain classes, it is not a requirement in any class. Other methods can include using carbon fibre and outsourcing production.

Assembly

Assembly can be achieved in several ways. Teams are encouraged to think about how components will fit together in the design and manufacturing stages. It is important that teams take great care in attaching components to car bodies to ensure the finished result achieves the required clearancesand overall dimensions in accordance with the Technical Regulations.

Glue can be used to assemble the cars. A good Loctite or gorilla glue goes a long way when it comes to assembly and running repairs.

Finishing

Form and finish can impact a large part of the appearance of the car, and cars are judged in these two areas. Students are permitted to apply some light sanding of their car body by hand in preparation for the application of sealer or finishing coats. Students are required to paint their cars, and this should be carried out with consideration of their team's overall branding.

In competitions, teams must take note of the advertising requirements using the correct decals, as stated in the regulations.

Notes:

- Manufacturing is very much an iterative process. Things will go wrong, and designs won't turn out exactly as they appear on CAD screen. To short circuit any problems it's best if students can get hands-on experience of manufacturing by using CNC machines rather than outsourcing.
- Students often make the mistake of thinking that their manufactured model will have the same dimensions as their CAD design. Manufacturing tolerance is a lesson they should learn early on.
- Designing an easy-to-assemble car or one that has pieces that fit together nicely will be highly regarded by the engineering judges. Students often overlook the effect glue and paint might have on the car's dimensions and weight leading to the car being out of specification and incurring possible deductions in scrutineering points.
- Students must document their errors and refinements. Learning about the relationship between their first concept and their final product is very much a part of the F1 in Schools journey and can be useful during judging.
- Students must consider the car's requirements in their design and manufacture. F1 in Schools cars experience a variety of forces and often the fast deceleration at the end of the track will cause breakages and highlight design flaws. Breakages

  can have a significant effect on a team's performance, and a well-engineered car should not break.

14. Racing & Results

Racing is always fun for students, and track testing can be very beneficial for teams. In general, organising a race-day where students can compete is a great way to use competition to fuel student drive to improve on their designs and processes. The F1 in Schools cars use an 8g CO2 canister for racing on a track that is 20m long and timed with accuracy within 0.001 seconds. Cars are tethered to the track and can reach speeds of up to 80km/h.

Racing in Competitions

Teams may race for the first time during competitions. For obvious reasons, it is a good idea to be able to race beforehand. In either case, there are many lessons which can be learned on the day.

Teams race in timetabled heats and given a time frame to make running repairs on their vehicles if anything goes wrong. It's worthwhile considering a robust design to ensure it makes it through a competition. In competitions, teams complete both reaction racing where they use a trigger to launch cars using a countdown and also automatic racing where cars launch simultaneously using the built-in electronic track mechanism.

Analysing Results

The best way to improve a car is to consider the results and consider how making adjustments can improve the car's time. Occasionally results can be a little unexpected, and small changes on the car can make a big difference. Weight plays a large part in a car's race times. Racing is always fun, but it should also be used as an opportunity to learn and improve on the car's design. Considering the large number of variables that can impact the performance of the car, it is essential when analysing results to only make one change at a time.

Analysing Design & Construction

Students may be able to develop a very fast car that isn't well designed or engineered. Considering how a design handles the speed on the track and the fast deceleration at the finish is critical to success, especially in the later stages of the competition.

It's essential to limit breakages. Repairs may have a significant effect on the weight and aerodynamics of a car. In competitions, there are restrictions when it comes to running repairs and having many breakages is likely to significantly hurt a competing team's chances of winning.

Calculations

Students will be able to do some calculations after receiving their results. Results are all in time units, so lessons around time and statistics lend themselves well when analysing results. While track testing can validate the speed of the cars, students also need to look into the variables that are in play when they use the track to test. To achieve accurate results, they need to remove or reduce as many variables as possible. Some of the variables are weather conditions, canister weights, car weight and track set-up.

Statistical Analysis

Considering results will also allow students to learn about averages and standard deviation. By looking at a handful of results for a specific car, students will be able to calculate its average run time and the standard deviation of their findings. Students can use these results when justifying their design process and car selection methodology.


15. Portfolios/Poster Submissions

Teams competing in the Development and Professional classes of competition are required to submit multiple copies of A3 sized enterprise and engineering portfolios outlining their progress as well as an engineering compliance booklet. Even if schools aren't planning on competing, students must learn to document their work and processes as a part of their F1 in Schools journey so they can get the most out of the program. Often in the real world, the process of decision making and development is just as important as a useful final product.

Enterprise Portfolio (Development & Professional classes only)

A team's enterprise portfolio outlines its processes for team management, communication, career relevance, marketing and collaborations. The enterprise portfolio includes information on the teams' processes for:

1. Project Management including roles, responsibilities and timeline,
2. Stakeholder engagement, collaborations and partnerships,
3. Finance and budget considerations,
4. Brand development, marketing and social media,
5. Career development,
6. Trade booth and uniform development and execution.

A significant takeaway for students is an understanding that a large project has many components which need to be managed to achieve a result. As in any project, documenting progress and justifying why specific approaches were taken is critical in demonstrating understanding of the decisions which have been chosen and also an understanding of the errors which may have been encountered.

Engineering Portfolio (Development & Professional classes only)

The engineering portfolio outlines a team's design process, research, car development, manufacturing and testing. Teams must record their issues and challenges early on and maintain a habit of recording their progress and choices.

It's useful to document all errors and adjustments and while not everything must be included in the final portfolio, being able to draw from a range of information is a great way to impress judges and is an essential part of the learning process for students. The engineering portfolio includes information on:

1. Car design research, ideas and development,
2. Innovations and design analysis,
3. Manufacturing and finishing processes,
4. Evaluation and testing of design.

Engineering Compliance Booklet (All classes)

The compliance booklet is used for engineering judging and contains CAD models, technical drawings and photorealistic renders of submitted vehicles. A third party should be able to pick up a team's compliance book and be able to manufacture the car using only the information contained.

Cadet Class Poster (Cadet class only)

In the cadet class, students produce a poster and compliance book rather than the enterprise and engineering portfolios mentioned above. The Cadet class poster should focus on their engineering development and analysis. The content is arranged within an 1 x A2 or 2 x A3 posters. Assessed in the poster are:

1. Ideas,
2. Analysis,
3. Evaluation
4. Overall design merit.

16. Marketing & Trade Displays

Marketing

For Development and Professional Class tams, an understanding of marketing and branding is a large part of the competition and is an excellent introduction to students on the multi-faceted requirements of most successful organisations. Having a fantastic product or solution is one thing but understanding how to communicate that product or idea is also critical to success.

An understanding of marketing is also a great way to engage sponsors and stakeholders - a well thought out brand incorporation strategy can go a long way when students are cold calling local industry for support and sponsorship. This applies to the team as they look to make a good impression and also to what they're offering any organisation they choose to approach.

Marketing is often a challenge for students, and by including it in the program, we hope that students will learn the importance of presentation and imagery. While marketing does stand on its own as a judging criterion, students may be able to identify a link between how they market their team and their ability to win sponsorship and industry collaboration opportunities. Something as simple as dressing well or having a uniform can make a big difference when canvassing for support.

Competing teams are required to use accurate branding for REA and affiliated organisations as stated on the REA website and competition documents.

Sponsorship Prospectus

Many competing teams will produce a prospectus which outlines an ROI for sponsors. These don't have to be complicated, but it doesn't hurt with marketing judges and in the fundraising process. In the past teams have been able to gather support from local businesses, whether they be large companies or local fast-food chains. In some cases, students might spend time mustering up the courage to knock on a door or phone a business but winning support is very rewarding for students and allows them to grow in confidence, an example of the many unique learning opportunities the F1 in Schools program provides.

Trade Display

In competitions, Development and Professional Class teams are required to plan, prepare and set-up a complete trade display strictly in accordance with the terms and conditions as outlined in the Australian Competition Regulations with an emphasis on portable, compact, pop up displays which are easily transportable.

Teams should design the display using 3D CAD and so that they can set up without teacher or adult help in a limited 2 hour time frame. The standard dimensions of trade booths are outlined in the competition regulations, and teams are encouraged to use their creativity to come up with innovative and unique displays.

Some restrictions are placed on Development Class trade displays for State Finals so it's important that teams adhere to these otherwise penalties are applied.

Above: Development Class Display
NSW State Final

Above left and right: Examples of Professional Class Displays
2019 Victoria State Final

17. Verbal Presentation

Students in the Development and Professional class will be required to deliver a verbal presentation about their car and experience in the F1 in Schools program. At competitions judging panels are sourced from industry as much as possible, and students are judged on both their presentation technique and presentation content based on the judging criteria below.

As with all judging, students must check the scorecards as they develop their responses to make sure the criteria are being addressed.

In presentations, students will have access to an data projector or large monitor to which they can connect their computers to play a media presentation and videos if requirede. Each student must contribute to the presentation. Presentations are limited to 10 minutes and judges will stop students when the time limit is reached. Judges may ask clarifying questions following presentations, and they also may offer feedback immediately after the presentation.

Sample Judging Criteria

2019/2020 F1 in Schools™ Australian Competition Regulations

CRITERIA 9 – VERBAL PRESENTATION: PRESENTATION TECHNIQUE SCORE CARD

Judging Sub Category	Presentation Technique	Team ID	
Primary Evidence	Team Presentation	Team Name	
Secondary Evidence	Nil	School	
Criteria	9	Competition Class	

	Low	Developing	Advanced	Score
Criteria	0 1 2	3 4 5 6	7 8 9 10	/10
9.1 Presentation Energy	Artificial and/or low energy	Speakers generally enthusiastic with lively delivery	Passionate with effective and appropriate levels of liveliness	/10
9.2 Team Contribution	Minimal team participation	Good contributions from most team members	Excellent team work with all members participating effectively	/10
9.3 Visual Aids	Little use of aids	Some aids used effectively	Well produced, highly relevant and integrated aids effectively improve communication	/10
9.4 Audience Engagement	Minimal engagement	Some audience connection at times	Audience fully engaged and excited throughout presentation	/10
9.5 Articulation	Difficult to understand and/or hear most presenters	Inconsistent speaking ability	Excellent articulation, use of language and voice projection by all members throughout the assessment	/10
9.6 Structure	No structure presented, difficult to follow.	A basic structure / outline provided and could be followed by audience	Clear presentation outline / overview. Excellent connections between topics and easy for audience to follow	/10
9.7 Timing	Too fast or ran out of time.	Good timing. Balanced topic depth and pace.	Ran on time or just under. Excellent balance of depth for each topic.	/10
			Presentation Technique GRAND TOTAL	/70

2019/2020 F1 in Schools™ Australian Competition Regulations

CRITERIA 10 – VERBAL PRESENTATION: CONTENT SCORE CARD

Judging Sub Category	Presentation Content	Team ID	
Primary Evidence	Team Presentation	Team Name	
Secondary Evidence	Nil	School	
Criteria	10	Competition Class	

	Low	Developing	Advanced	Score
Criteria	0 1 0 1 2 0 1 2 3 4 5	2 3 3 4 5 6 6 7 8 9 10 11 12	4 5 7 8 9 10 13 14 15 16 17 18 19 20	/5 /10 /20
10.1 Team objectives	Limited statement of objectives	Good statement of objectives	Excellent statement of objectives supported by sound reasoning	/5
10.2 Description of Car Product	Basic descriptions	Good description of components and features.	Excellent description of components and features including design decisions.	/5
10.3 Innovation	Little innovation presented	Innovations described and justified	Originality. Clever innovations with high positive project impact	/15
10.4 Refinement	Little refinement presented	Refinement described and justified	Clever refinement with high positive project impact	/15
10.5 Collaboration	Little collaboration discussed	Links with industry or higher education described	Collaborations justified with links to learning and project outcomes	/20
10.6 Learning outcomes	No real reflections discussed	Good explanation of some learning outcomes	A range of personal, life-long learning and career skills acquired and identified as project outcomes for a range of team members	/15
10.7 Future Career Aspirations & Research	Little or no thought had been given to future career aspirations.	Evidence of some team members researching careers generally but no linkage to opportunities in Defence or Defence Industries.	It is evident that team members had thoughtfully considered their future career aspirations and undertaken research into how these might be linked with opportunities being offered in Defence Industries.	/15
10.8 Overall clarity	Several concepts lacked clarification	Clear and appropriate concept explanations	Everything presented was understood through excellent explanations	/5
			Content GRAND TOTAL	/95

18. Project Management

Project management is a critical component when it comes to success in F1 in Schools. When managing the project, it's essential that students consider all aspects of the competition and what might be required. They will find that throughout the process things might not work out as expected but starting with a plan is essential.

Project management is a component of judging so students must document their process for management in all aspects of the competition which may include how they raised funds, managed time, developed as a team and communicated with industry.

Assigning Roles

When it comes to roles, teams must consider the requirements of the program. There are no rules regarding roles, but they should be allocated based on each student's skills, experience and interests as well as the required project tasks. By considering different aspects of Engineering and Enterprise judging, teams should form their team into functional roles as they see fit. It might be a good idea to flip through some past portfolios to gain insight into how other groups have assigned roles in the past.

Below are some aspects of the competition and some roles that might match. Again, there are no strict rules on roles, and there will be plenty of overlap. Each team will have it's own unique set up where students are responsible for certain aspects of the project. Combining roles and creating new roles is always an option for teams. Students can make up their roles and titles - below are some ideas or examples:

Task	Role Title
CAD Design and Research	Design Engineer
Car Manufacture and Testing	Manufacturing Engineer
Marketing and Trade Booth	Marketing Manager
Cost and Resource Management	Resource Manager
Industry Collaboration	Industry Relations
Printing, Signage and Graphics	Graphic Designer
Time and Project Management	Project Manager or Team Manager
Raise Funds and Find Sponsors	Sponsorship Manager

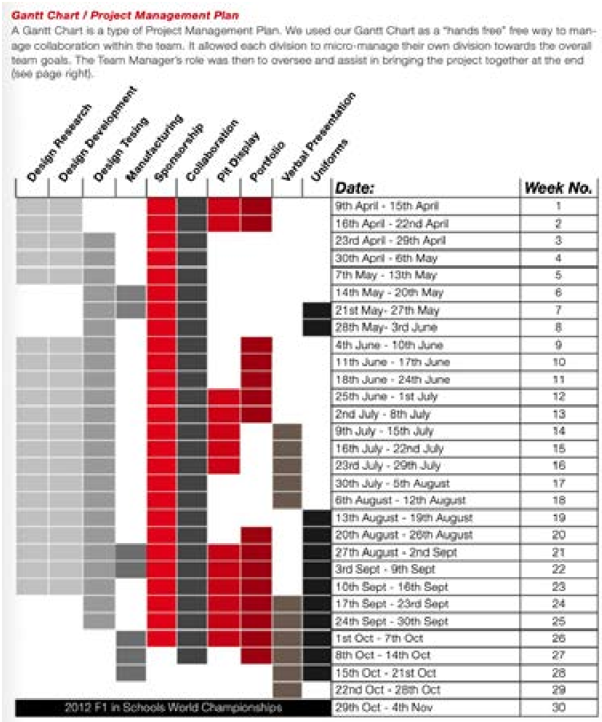
Time Management

On the right is a Gantt chart taken from an example portfolio. This chart was likely created after a lot of the actual work was done, but students must have a plan for how they'll manage their time and keep track of their progress.

Often students will struggle to adhere to or create deadlines and teachers might be able to push and prod students in the right direction. As with most high school projects, leaving things to the last minute does occur with F1 in Schools teams and will often lead to problems.

Teams may work on the project for a couple of terms but not produce their car in time for the competition. Time management is critical and an important concept for students to get their head around early in their F1 in Schools journey.

The Australian Institute of Project Management (AIPM) and the Australian Government Department of Defence (DoD) have combined their efforts to produce a Project Management Guide to assist students which can be downloaded from the Resources area of the F1 in Schools webpages.



19. Sponsorship & Fund Raising

Government Grants

Applying for grants is an option when starting to raise funding for the team. Each State Government is likely to have funding options in place to support student projects. Local Government Councils also provide access to community grants.

A grant that has benefited competing students in the past by the Australian Federal Government's Department of Industry, Innovation and Science is the grant for Student Science Engagement and International Competitions which can be found at -

https://www.business.gov.au/sgseic

Raising Funds

Students are required to raise funds and resources throughout the competition. This can be a challenge for students, but it can also be enriching. In many cases, sponsors are happy to help a keen group of students, especially when teams can outline how they will be looking to benefit their sponsors.

Going for local sponsors is a great way to get communities behind successful F1 in Schools teams. In the past teams have been able to get support from many local industries and can strategically offer sponsorship opportunities which are mutually beneficial to sponsors. For example, students might be able to get a local shirt printing company to make their team shirts for free or with some branding recognition.

Many teams have raised funds through their local Bunnings sausage sizzle days but you need to book well ahead.

An Example - Using Trade Displays to Generate Funds and Awareness

Students are often able to come up with creative ways to raise funds. A team from Mount View High School in NSW was able to raise funds by leveraging a student's parents store in the local community. In the shop front, the team set up some branding material and a short letter to passers-by on what was involved in their project. The team displayed their cars, parts of their trade booth and several trophies they had won - in doing so they were able to receive contributions which helped get them to the 2019 world final.

Using trade displays to generate attention is a great way to raise funds. Some stores have spaces for community projects to be advertised. In many Bunnings stores, they often have areas where students can set up their trade displays to generate funds or awareness of their project. Investing in a good trade display which can be re-used has some other benefits too. Many schools will set up past team trade displays in school libraries or hallways to display for students who aren't competing and also for new students and parents on school open days.

Persistence is Key

In many cases, students will need to get a list of organisations and start calling. It's a difficult task for students, but it does allow them to learn a lot about how they sell themselves and their project.

In some cases, students will be denied any opportunities, but we do find that when students are well prepared that companies and organisations will look for ways they can contribute - whether with direct financial contributions or through products or services they offer.

Some businesses are happy to donate goods or services that can be auctioned off as prizes at fundraising events or school fetes.

20. Collaboration & Mentorship

Industry collaboration is critical to success in F1 in Schools and greatly encouraged. In fact, it accounts for some significatn points within the Verbal Presentation Content scorecard. A large part of the program is opening up opportunities with industry for students to gain a better understanding of current best practise. Students have a lot to learn from involving experts in various fields, whether in engineering disciplines, communication or design and graphics.

It might take students a few days or weeks to gain the confidence to contact a company and ask for help or to organise a meeting. This very much is a part of the program, and the confidence gained from successful partnerships is a huge opportunity for students. For students, it is by no means is an easy task to gain industry support, but in our experience, we find that many companies respond positively to student contact.

It's best to consider your local industries and to encourage the students to get involved. Taking advantage of any existing relationships the school may already have is a great place to start.

Contacting REA is also a good option if your students are struggling for industry collaboration but pushing students to make more calls can also be quite useful.

Creating Partnerships

Creating partnerships with other organisations is a great way to generate a foundation for F1 in Schools at your school. This may involve a broader commitment from school executives to the program but in the long-run, will make collaboration easier for teams at the school.

In Adelaide, SAAB Australia has developed a fantastic partnership with about six schools at the time of writing. Saab graciously gives time for its graduate engineers to mentor and collaborate with teams and students taking on the SUBS in Schools competition.

In WA, schools in the past have been able to work with graphics artists who have supported REA competitions. "AndyK Graphic Artist" in Beechboro WA has supported the competition and collaborated with many teams over many years. Andy has supported the competition through mentoring and judging.

REA has a long-standing relationship with Visual Connections, who is a significant sponsor of REA. Visual Connections is the governing body for the print and sign industry and have offered to locate printers and signwriters which have been useful for competing teams in the past. Use the link below or contact REA for more information on industry partners through Visual Connections.

We strongly encourage schools and students to forge relationships in their local community. A great by-product of F1 in Schools is the ability to bring communities together to support the growth and development of students in their area. REA will assist as much as possible to create partnerships with industry, but the onus should be on students attempting the competition as they have the most to gain out of understanding how corporate relationships work and forging partnerships for themselves. Please contact REA for more information or use the links below to submit a request for mentors or industry partners.

- https://rea.org.au/industry-mentoring-request-form/

Judging Panels & Feedback

Judging panels are sourced from industry wherever possible. Judges are an invaluable resource to competing teams as they assess student work. They benchmark team submissions and after each competition students are given feedback in the form of judges scores and comments.

During competitions, we encourage students to do their best to approach judges floating around the complex to ask them questions that are relevant to the judge's area of expertise. Students can talk to judges about what the judge does for work, whom they're representing, and if they have any tips or suggestions for their team.

21. Reflect & Refine

Team Evolution

Building a culture of growth within a school goes hand-in-hand with running a successful STEM program for students. Most schools will run F1 in Schools consistently every year and have teams "coming up through the ranks". Using older students to mentor younger teams is a great way to help students grow and learn - in some cases students learn more from other students than from teachers.

Teams themselves are often chopping and changing. From year-to-year groups may change and re-form with changes in the team name and some group members. Having a whole-school plan for STEM and allowing students to compete in consecutive years will ensure they get the most out of F1 in Schools.

Example Team Evolution

The two snapshots below are from the 2019 National Final enterprise portfolios of two teams which joined together to compete in the 2019 World Finals in Abu Dhabi. The team on the left, Nebula from Wesley College in Perth, WA has outlined their team's evolution throughout their years of competing. The snapshot on the right is from team Quantum Overload from Mackay North State High School in Mackay, QLD. Both pictures taken from their 2019 National Final portfolios show that each team had its own history and development. With guidance from REA the two teams combined and were able to create a new collaboration team, Ionic, which competed and achieved an overall placing of 9th in the 2019 World FInals - an incredible result. Further to this result team Nebula ranked 1st in the Australian National Finals in 2020 and will go on to represent Australia as a standalone team at the next world final.

While this isn't necessarily a typical example of team evolution, it does demonstrate that teams grow and improve over time. Schools which facilitate this growth will often have teams which will be able to capitalise from the continuity of running the program.

Team History

Four Year 9 students from Wesley College, South Perth have taken on the mantle of continuing the team Nebula Racing. In the 2017 and 2018 seasons, Nebula Racing successfully won the WA State Finals. As state winners in 2017, Nebula Racing attended the 2018 National Finals. They had a great experience, and learnt a lot from attending. Nebula Racing came 11th in the Development division and were proud of all their work and achievements. Now they are looking ahead towards the 2019 season aiming to beat their past records and proceed through to the International Finals. With the start of the 2018 State Finals season some of the foundation Nebula Racing members opted not to continue the program, hence the team recruited 2 new members from the 2017 F1 team Velocity Racing who participated in the 2017 WA State Finals as a Professional class team. As the ideology of both teams were very similar, integrating the two new team members was a quick process which resulted in a strong collaborative team structure. Nebula Racing are continuing to apply this ideology, by making everything at the standard required as if they were competing at an International competition.

Nebula Racing are extremely grateful to REA and F1 in Schools for providing them with this opportunity to participate in this very rewarding competition. Each team member has already learnt many individual and collaborative skills from their experiences in previous seasons and look forward to building further skills during the 2019 season. The skills learnt as a result of this competition will be extremely beneficial to each team member in the future when they apply for jobs. REA has provided a fun way to express creativity while studying in high school, with each role within the Nebula Racing team the equivalent of an actual position in a company.

Nebula Racing – WA State Finals, 2017/2018 Season

In our first competition as a Development class team, we had huge successes, with fast race times, innovative designs and several high profile corporate sponsors. Our branding was also very good, with our team uniform considered to be the best in the State Finals competition. Our booth stretched the limits of the Development class rules demonstrating innovation and creativity. In the 2017 State Finals Nebula Racing finished 131.6 points ahead of the nearest team, and were ready to go to the National Finals.

Nebula Racing – AU National Finals, 2017/2018 Season

After a successful 2017 state competition, Nebula Racing went to the 2018 National Finals as a Development class team. A few small, but detrimental oversights resulted in a lower point score than we anticipated. However, with a ideology of "you get better when you learn from mistakes", we analysed the errors we made in the aim not to repeat them. An example of a mistake we made was not continually checking the weight of the cars, and this resulted in cars that weighed well over the minimum mass, among other problems. However, we were proud to have made it to the National Finals and were impressed with the results of our work to get there.

Velocity Racing – WA State Finals, 2017/2018 Season

Velocity Racing competed as a Professional class team in the 2017 WA State Finals., finishing in 3rd place, one spot away from attending the National Finals. While they were preparing for the next season, one of their three team members left, and they had to find another person. However, Nebula Racing also had two team members decide to focus on their studies, and happily took on the two enthusiastic and highly experienced team members, Chris and Aarav.

Nebula Racing – WA State Finals, 2018/2019 Season

With a fresh start to a new season of the competition, the new Nebula Racing concentrated on their preparation, accrued lots of resources, finances, and mentors in the early stages, which gave them a great head start on the other stages of their work. With the hard work put in early, Nebula Racing were able to allocate resources to components and materials that aided in their success such as high quality bearings and high resolution posters. With experience from past seasons refining the way they delivered their work, Nebula Racing came first in the 2018 WA State Finals, albeit not having the fastest car.

About Us

Quantum Overload currently consists of Five team Members, broken into two key areas, Engineering and Enterprise. Splitting the team this way was more suitable with how our team works. Quantum Overload competed at the 2018 National Finals as a Development Class team and this season competes in the Professional Senior Class. After the 2018 National Finals, the team returned home and started preparation on the Regional Finals. After winning at the Regional Finals, we then proceeded onto the Queensland State Finals which we won and set our eyes onto competing at a National level. Quantum Overload leaves each finals inspired by the workmanship of innovation, designs and presentations by other teams.

Scope, Time & Goal

Having been to a National Finals, our team has prior experience but there are also changes that can be made to improve our performance. Quantum Overload set goals after State Finals which was to improve in verbal presentation content, marketing and time management. One of the key points that we discussed was time consisting of working out a time frame of all our 'out of town' orders like, shirts, graphics, Christmas break and new years break as well. Quantum Overload has set 3 goals for National Finals which are to improve in time management, collaboration and marketing while still maintaining our verbal presentation at a high standard.

22. Process Timeline

The Journey

Schools can create their own F1 in Schools Journey, but there is a specific path which is required to reach the world finals. New schools shouldn't worry about the road to the world finals until they can set up a strong system for STEM within the school. Schools should focus on implementing the program for all students, not just those who will be looking to advance and compete. Within a school, it makes sense to run yearly cycles for STEM in which F1 in Schools can be a significant program.

The timeline below is the general outline for how a team may progress through to the World Finals. Below is a general guide for which terms the events take place but the actual dates must be checked using the information posted on the REA website and may be different to the guide below. For example, a State final may be held later in term two or early term four depending on circumstances but will generally be in or around term 3.

Year 1

Term 1 - Get started, introduce students to the concept of F1 in Schools competitions and maybe begin to work towards internal school competitions. This can be a yearly competition coordinated by STEM teachers and also offers an opportunity for students who previously took part in F1 in Schools to share their learnings with new teams and students.

- *Register your school with REA as early as possible. This is required yearly and has no cost involved.*

Term 2 - Complete the development of some cars and hold an internal competition to select the best teams at the school. Success at a regional final may be required in QLD and NSW before a team can advance to a State or National Final.

- *Ensure any teams looking to compete are registered by their TEACHER. This is separate to school registration and should be one of the first things teachers do after teams are formed.*

Term 3 - Get involved in REA competitions in your State. State Final dates can be found on the REA website, and the REA team can be contacted if you need any guidance or support.

- *Teams are not guaranteed to progress past the State finals and for many teams this will be the end of their F1 in Schools competition journey and will need to try again the following year.*

Top placing teams continue through the process.

Term 4 - Prepare for national final using learnings from State Finals. Teams will often require a more comprehensive approach to the national final. Feedback from State Finals should be applied to improve aspects of student submissions where possible.

Year 2

Term 1 (March) - Australian National Final commences. Winning teams and top performers are selected by REA to represent Australia on the world stage. Recently the National Final has been held in Melbourne ahead of the actual F1 race which allows students to be a part of the real F1 competition and do some back-stage tours coordinated by REA.

Professional Class champions advance as a standalone team and Development class champions advance as a collaboration team under REA direction.

Term 1/2 - Teams prepare for the world finals using the rules and regulations for the international competition. Much of the student work can be easily adapted, but there are some aspects which need to be addressed - for example, the World Finals requires the use of a foam body rather than a balsa body. Considering international transportation and logistics is also a factor in international competition.

Term 3 - World Final Competition is held. World final teams are given a chance to compete again at the following Australian National finals without a requirement to compete in state finals.

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

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

School & Team Registration - https://rea.org.au/f1-in-schools/fees-and-registration/

Contact REA for More information on Competitions

23. Competing

Who should compete?

Staff should use their professional judgement as teams decide whether or not they want to compete. While teams will benefit immensely from competing, judges are generally from industry and volunteering time from their job or business to contribute their expertise in judging student submissions and presentations. If students put forward poor submissions, they will receive poor results.

A balance between using the event as a learning opportunity and motivating students by using an incentive of a podium finish is ideal. There is no limit on how many teams can be put forward by a school but REA may ask schools to whittle down their entries to ensure that all schools in an area are given an opportunity to be represented.

Australia on the World Stage

Australia has done very well in F1 in Schools in the past. REA is very proud of student results and is always looking to innovate and improve the program using our experience and feedback from students, teachers and judges. In some cases, judging categories in the global competition are founded on innovations from Australian competitions. Running well-thought-out and rigorous competitions are one of the ways we prepare students to succeed on the world stage.

Teams don't have to come first to achieve benefits form the international competition, exposure to F1 teams and a broadening of perspective from overseas travel are just some of the many benefits students gain from competing in the World Finals.

F1 in Schools Competition Regulations

Just like the real F1 sport, the F1 in Schools program requires teams to follow guidelines in the production of their car and documentation. Competitions run according to the rules and regulation documents. The competition regulations can be found on the REA website, which are updated from year-to-year. Giving students a copy of the regulations early on is very important in ensuring they know the full scope of what's allowed and what's required in the program. The regulations documents can be found using this link - https://rea.org.au/f1-in-schools/resources/ under the "Rules & Regulations" heading.

- *Teams will need to be aware of two regulation documents. The Technical Regulations and the Competition Regulations.*

Not Sure if you should Compete?

The process at first for students should be similar whether they're competing or not. For REA competitions, students must document and keep track of their progress so that it can be used in their portfolios and verbal presentation. Documentation of student work is good classroom practice. Our research has shown that the hands-on components of the program rate highly with students, this suggests that students might not have an interest in competing until they start producing a final product. Students are required to submit two portfolios, one for their engineering processes and one for their enterprise process. Depending on their class, students may also be required to put together a verbal presentation and trade booth display, so record-keeping and planning are a must.

Throughout the CAD process, it's good to let students play and figure out how CAD works before giving them the technical regulations. Students can work on the project and should be able to transition from a non-competing team to a competing team quite easily if they have a good understanding of each of the elements of the program and understand the importance of time management. Awareness of registration deadlines and competition dates is also vital for teams early on in the process of their journey.

24. First Steps

Register on the REA Website

Whether entering a competition or not, the first step is that schools register on the REA website. This will allow REA to monitor school progress and open the line of communication with the school. Deadlines apply. There is no cost to register and registration is via the "fees and registration" page on the REA website - https://rea.org.au/f1-in-schools/fees-and-registration/.

A "Team Registration" is required once teams are formed and looking to compete in Regional or State Competitions. Deadlines apply.

Engaging Students

Schools might like to introduce your students to the program before encouraging them to commit. The program can be promoted within a school at an assembly, through a newsletter or subject selection evening. REA has a lot of promotional videos available on YouTube and has a PodCast channel "Above and Beyond" which includes interviews with teachers, past students and industry. The videos of the most recent State or National Final is a good starting point. Some other good options are listed below:

YouTube

- "F1 in Schools World Finals Abu Dhabi 2019 Highlights" - F1 in Schools HQ
- "The Life of a Bolt" - Aston Martin Red Bull Racing
- "Race To Race: The Story of an F1 Nose Cone" - Aston Martin Red Bull Racing

Podcasts (Apple podcasts & Whooshka)

- Above & Beyond - REA Foundation

Meeting Times

Once students commit to the program, the next step is to consider when the team will be meeting. Teams can chop and change quite a bit in the early stages, but students need to document their process from the get-go for their learning and possible later use in portfolios.

It's up to the students to plan and organise their time, but supporting staff can certainly point them in the right direction. If schools are running the program across an entire cohort, there might not be a need to organise additional sessions.

Roles and Responsibilities

Once teams form, everybody on a team must know their role. Students will have different interests. Some will want to design using CAD and others will want to be involved in manufacturing, management or marketing.

It's essential to explain to students that different roles will help the project come together to produce a final product. It's a good idea to show them what the end product might look like - there are example portfolios available on the REA website and REA competition videos on YouTube will give students an idea of what's involved. Visiting an event before competing can also be beneficial.

It's also crucial that the students are on the same page. While not all students will have the same responsibilities there is a lot of overlap and working together will benefit the team overall. As an example, team judging takes place in several areas and while students can manage who answers specific questions, it will come across better in the judging process if all team members have at least some understanding of all aspects of the design, test, manufacture and review process, even if they aren't directly responsible for that process within the team.

Competing teams should be directed to the F1 in Schools Technical and Competition Regulations documents with the onus being on students to adhere to the rules outlined.

Regulation Documents & Team Registration

Competing teams should be given the regulation documents as early as possible with the understanding that the documents are updated every year. There are two regulation documents, the Technical Regulations and the Competition regulations, both available from the resources page on the REA website under the "Rules & Regulations" heading - https://rea.org.au/f1-in-schools/resources/

REA asks that all schools taking on F1 in Schools register on the REA website. Schools with teams looking to compete must also register their specific teams as early as possible on the REA website - https://rea.org.au/f1-in-schools/fees-and-registration/

25. Competition Levels

F1 in Schools is a global competition with the 2019 world finals having 55 of the top teams from around the world competing in Abu Dhabi for the World Finals event just before the last F1 race of the year at Yas Marina Circuit.

There is, however, no requirement to enter into any competition. Schools may wish to compete internally within the school or even on a class-by-class basis.

If teams do wish to compete, they can attend their Regional Final (at no cost) or State Final, which does have a cost involved for each team. The State Finals include a large number of teams and are usually coordinated by REA directly in consultation with the F1 in Schools regional coordinators.

If successful at the State Finals, teams are then invited to attend the Australian National Final which involves schools from all across Australia. If successful at this level, you may be invited to participate in the World Final.

Summary of Australian Competition Levels

Intra-school	Regional Final	State Finals	National Final
If you don't think your students are ready for a competition or if you're new to the program you can run F1 in Schools within your school. Dropping in to an REA event will give staff an idea of what's involved and can be useful.	Some States are required to run regional competitions due to a large number of entries (currently NSW & QLD). You also might want to run a competition with some local rivals before you decide to go to a State final or to prepare.	These are held around term 3 and are REA organised events. Teams from across the state compete for a shot at the National Finals. Dates can be found on the REA website when available.	Most recently this has been held in March in Melbourne, just before the F1 race. Students from across Australia enjoy a range of activities and access to the F1 track itself. It's a huge event with a lot of peer and industry networking opportunities.

World Final

Takes place towards the end of the year generally between September or November, and has recently been in Singapore and Abu Dhabi. It's an enormous event with schools from all around the world attending and competing for the F1 in Schools World Championship. Students take advantage of networking opportunities with their peers from across the globe, major companies and F1 teams.

Overall the experience is like no other with many celebrity appearances and exposure to eye-opening innovations. Internships and scholarships are on offer for top student attendees.

Regional Competition Regulations

State and National competitions all follow the official REA regulations documents. Regional competitions however, are run by regional coordinators and whilst the assessable criteria used in regional competitions is modelled on the official criteria, there may be some differences. For example, some regions might run a competition based on reduced criteria which simplifies the event for volunteer coordinators.

Regional coordinators can be found on the REA website or by contacting REA directly - https://rea.org.au/f1-in-schools/contacts/

26. Competition Classes and Levels

The classes of the competition provide a series of stepping stones students can use to increase their skills and competencies. These classes are Cadet, Development and Junior & Senior Professional Classes. The different classes have different regulations which increase in complexity and teams will need to be aware of these differences. A team's class will determine which competition and regulation guidelines they should follow.

Teams may only reach an intra-school level which would not involve any external competitions, or they may progress through all the levels of official competitions, starting at regional (if required) then going on to State Finals, National Finals and finally, World Finals. To participate at the higher levels of competition teams need to achieve a high placing at previous levels or are offered a wildcard invitation.

While teams can't choose to enter National or World Final competitions (participation at these levels must be earned) it's a good idea to keep the structure of the overall competition in mind and allow the teams to develop their expectations and goals.

Class Structure

Difficulty Level	Class Level
Low Difficulty	No-Class (within the school only)
	Cadet Class (Does not Progress past State Competition Level)
Moderate Difficulty	Development Class
	Professional Class
High Difficulty	World Finals (Rules and Regulations determined by F1 in Schools International)

Competition Structure

Difficulty Level	Competition Level
Low Difficulty	Intra-school Competition
	Regional Final (Only in Specified Locations)
Moderate Difficulty	State Final (REA Event)
	National Final (REA Event)
High Difficulty	World Finals (F1 in Schools Global event - Rules and Regulations determined by F1 in Schools International)

Frequently Asked Questions

Do all students have to be in the same year level?

Teams can have students from any year level. However, teams with students in year 10 or above will be required to enter into "Senior" classes and won't be able to enter the development or junior classes of the competition.

Can my school enter multiple teams into the competitions?

Schools can enter as many teams as they like. Teams must, however, be able to demonstrate a capacity to deal with the competition. Merely entering a team because they have a completed car isn't always a good idea. In some cases, REA may ask schools to reduce the number of teams entered to ensure all schools have an opportunity to be represented.

I have a group of keen students in year 7, can they enter the Professional Class?

Yes, they can but it needs to be the Professional Junior Class. Year 7s may struggle to compete against older students, but you might want them to experience this unrestricted level of competition. If competing for the first time, starting at the "Development" class would likely be better so students can compete with others their age.

27. Cadet Class (1-3 members)

Cadet class is the entry point for the competition. Students need only need to produce a car, poster and an engineering compliance booklet. At this level, students are not permitted to use 3D printing in their design. The Cadet class does not have a pathway to the National Final or World Final. This class is further divided into Cadet Junior (years 5-9) and Cadet Senior (years 10-12), but we would encourage older students to take on the professional class rather than Cadet class.

What grade levels are permitted in this Class?

Cadet Junior - Years 5 to 9

Cadet Senior - Years 10 - 12

Who should enter this class?

Students competing for the first time in F1 in Schools are allowed to enter the Cadet Class.

This is a good entry point into F1 in Schools and is the simplest class to run. It's great for younger students and students who might not be confident in a competitive environment.

This class is broken down into junior and senior cadet however we do recommend that older students take on the more challenging classes.

What equipment is required?

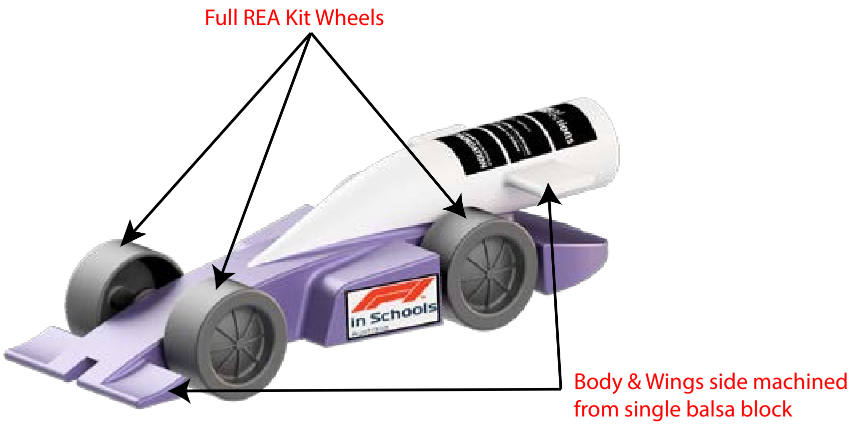
In this class students are required to build a CAD model of their car so computers and CAD software are required.

The teams will need to produce a poster and an engineering compliance booklet so printing is required in this class. It's likely that a school printer will be sufficient.

Access to a CNC Router to machine the car is required.

Class-specific requirements/rules

- All team members must be competing in F1 in Schools for the first time.
- Students produce a poster and car only. An engineering compliance book is also required but should be simple to produce using the CAD software used to design and make the car.
- Cars must be machined out of a single block of balsa wood using mirrored side machining only.
- Cars must use standard REA kit wheels, axles, grommets and tether line guides.
- There is no pathway to the national or world finals from this class.
- There is no public speaking requirement in this class.
- Students will not be required to face a judging panel



North Mackay State High School Cadet Design

28. Development Class (3-5 members)

This class is targeted at students competing in F1 in Schools for the first time or that have only previously competed in the Cadet Junior class. Development class teams may be just as good as Professional Class teams but it's simply their first time competing in the competition.

What grade levels are allowed in this Class?

All team members must between year 5 - 9 or below.

Who should enter this class?

Students competing in this class are entering the competition for the first time or have previously competed in the Cadet class only.

Students can only compete in the Development class once. Any teams with students who have previously competed in the Development class or with students in year 10 or above must enter the Professional Class.

What equipment is required?

Students will require access to computers and CAD software.

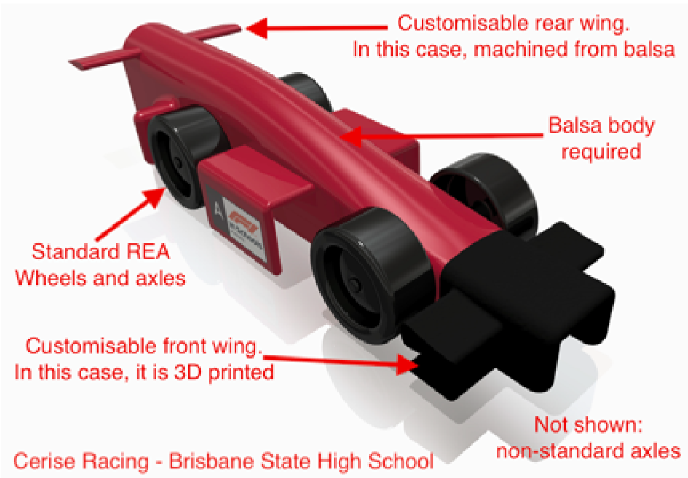
Students will need to document their progress for their portfolio submission using software - for example, Google services, Microsoft Office or Dassault Systemes 3D Experience team management software ENOVIA.

Students will require printing for their portfolios and compliance books. Students will also need to develop a display for a trade booth.

Students need to produce a model F1 car based on their CAD design using a CNC router. Students may also use a 3D printer to produce components, there is no mandatory requirement for 3D printing and other methods can be used.

Class-specific requirements/rules

- Teams with students in year 10 or above cannot enter this class.
- Students entering this class must be entering the competition for the first time or previously have only entered in the Cadet class.
- Students must use REA standard wheels and grommets but can substitute the axles and tether line guides.
- Cars must be machined from a single block of balsa using mirrored side machining **OR** top and bottom machining, but not both.
- Teams MAY manufacture their front wing from an alternate non-metallic material. 3D printed is one alternative.
- To be eligible to enter the World Final teams must form a collaboration team.
- Students need to deliver a 10 minute verbal presentation and will undertake engineering and marketing interviews with judges.
- At State Finals, teams produce a 7 page enterprise and 7 page engineering portfolio and adhere to more simplified trade display arrangements but at National Finals, this increases to 11 pages for each portfolio and there are no restrictions for trade displays.
- Teams produce two identical model F1 cars based on their CAD design and an engineering compliance book.



29. Professional Class (3-5 members)

This is the highest class level and teams competing will be able to participate at the world final if they do well at the national level. This class is also broken down into Junior Professional and Senior Professional. If ANY team member has previously competed in the development class then the team must enter the professional class. If any member is in year 10 or above then they must enter the Senior Professional Class.

What grade levels are available in this Class?

Junior Professional - All team members in years 5 - 9.

Senior Professional - Any team member is in grade 10 - 12.

Who should enter this class?

This class is for students who have previously competed in the Development Class of F1 in Schools or are looking to compete at a higher level with no imposed restrictions other than those outlined in the general technical and competition regulations.

Both junior and senior classes compete against each other and have the same judging process.

This is the highest level of competition in Australia and offers students the most opportunity to demonstrate their innovation.

What equipment is required?

Students will require access to computers and CAD software.

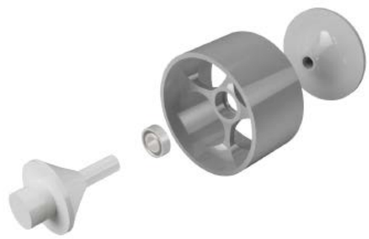
Students will need to document their progress for their portfolio submission using software - for example, Google services, Microsoft Office or Dassault Systemes 3D Experience team management software ENOVIA.

Students will require printing for their portfolios and compliance books. Students will also need to develop a display for a trade booth.

Students need to produce a model F1 car based on their CAD design using a CNC router. Students may also use a 3D printer for wings however there is no mandatory requirement for 3D printing and other methods can be used.

Class-specific requirements/rules

- Students who have previously competed in the Development Class or in year 10 - 12 must enter this class.
- Students can manufacture or outsource the car wheels as they wish. Student-made wheels aren't always better than REA standard wheels but well designed and manufactured wheels may score teams more points.
- There are no restrictions on machining the cars beyond the general rules and regulations.
- Teams can enter the World Finals if successful at the National Final (1st place go as a standalone team).
- Students need to deliver a 10 minute speech and will be interviewed by a panel of judges on their engineering and marketing.
- Students produce an 11 page enterprise portfolio, and 11 page engineering portfolio, an engineering compliance book, a trade booth display, a 10 minute verbal presentation and two identical model F1 cars based on their CAD design.



30. A Day At The Races

REA is responsible for running the F1 in Schools State and National Final competition events within Australia. Each event has it's own schedule and specific requirements but in general most events will run over 3 days and have the following components.

1. Registration & Element Submission

At the beginning of each event teams will register their arrival and submit the different components of their project to REA staff. It's critical that teams are aware of what's involved in their submission according the competition regulations for their class. Teams will submit the following with the exception of Cadet class teams which submit one car and one poster rather than enterprise and engineering portfolios:

- Two identical model F1 cars with required decals (Decals are provided on the day),
- Two identical enterprise portfolios,
- Three identical engineering portfolios,
- One engineering compliance book.

About 1-2 weeks prior to the event, teams will also be required to submit electronic copies of CAD design files, portfolios, compliance booklet and all forms.

2. Trade Display Set-Up

Teams are given two hours to complete the setup of their trade display. The two hour limit encourages teams to be practical in their trade booth designs. No non-team member is permitted to help. The set-up may be scheduled as one session or teams divided over two sessions depending on space and timing available. The display dimensions are outlined in the competition regulations document.

3. Scheduled Judging Events

Throughout the days teams will be rostered on for judging at certain times. Judging times may be scattered throughout the day and it's up to the teams to keep track of their schedule. Maps of judging locations are physically posted around the event and explained during the opening ceremony. Maps and schedules will be sent ahead of the event but it's important to keep in mind that there might be last minute changes in which case updates will be sent to teams.

All team submissions are judged including portfolios and cars. Development and Professional Class teams speak with judging teams when undertaking:

- Trade display interviews,
- Engineering CAD and manufacturing interviews
- Their verbal presentation.

4. Scheduled Racing

Racing is also scheduled throughout the day. Teams will have two races at a time, one race in each lane of the track and will go head-to-head with another team on the track, switching lanes after they have raced their cars (one car for Cadet and two for other classes). The racing is divided into automatic racing and reaction racing. In automatic racing students do not launch the car but the car times are recorded. In reaction racing students must launch their cars using triggers. In general, reaction racing is after automatic racing.

Knockout racing generally occurs after automatic and reaction races are finished. In knockout racing teams go head-to-head using the reaction racing triggers and the last team left standing will score maximum points and of course, receive full bragging rights.

5. Awards Presentation

Throughout the event days, judges update their results online after deliberating with their fellow judges. Each panel of judges is responsible for judging a detailed category of student submissions. Judging criteria used in competitions is identical to the criteria found on the last pages of the Competition Regulations. Judging results are combined with race times and the winners are announced for each class. In addition to 1st, 2nd and 3rd placings, there are also category awards which consider more specific aspects of student submissions., These can be found on the following page.

31. Awards and Recognition

Awards & Prizes

Awards are allocated based on performance in specified categories. All categories which contribute to awards are outlined in the Competition Regulations document within the Awards Matrix.

The results for 1st, 2nd and 3rd are produced from the sum of overall score across all marking criteria. Other awards listed below are selected from specific judging criteria which are highlighted in the competition regulations document.

Overall Awards

Based on the overall scores, teams are awarded 1st, 2nd and 3rd. Points are based on an accumulation of all judging categories.

The full assessment criteria can be found on the last pages of the competition regulations document. It's important to point your students to the scorecards as students will often miss easy marks because they don't look at the criteria - just like with their regular school assignments.

Category Awards

Students are recognised for their achievements even if they don't place on the podium. Certain judging criteria contribute to the awards below and are highlighted in the judging criteria available in the regulations documents. It is possible for podium teams to also be awarded multiple awards and there is no guarantee that teams will win awards beyond participation.

Development & Professional Class Awards	
Grand Prix Race	Best Engineered
Fastest Lap	Best Engineering CAD
Knockout Champions	Best Manufactured Car
Best Reaction Time	Best Managed Enterprise
Best Team Portfolio	Best Team Marketing
Best Graphic Design	Best Team Trade Display
Best Team Verbal Presentation	Outstanding Industry Collaboration
Innovation	Chair of Judges Recognition
Best Newcomer (National Final Only)	
Australian Motor Sport Award (National Final Only)	
Engineers Australia Women In STEM Award (National Final Only)	
Best Newcomer (National Final Only)	

Cadet Class
Fastest Lap
Best Team Poster
Best Engineered Car

Progression

Champions in class categories automatically progress to the next level of competition. At REA managed finals, some teams will be offered wildcard invitations. These invitations are at the discretion of REA staff and are not necessarily based on final rankings of teams. World finals teams are selected from the national final and collaboration teams may be formed under the guidance of REA.

Participation Certificates

At REA competitions all competing students are providied with a certificate for their participation and at national finals,this also includes a medallion.

32. More on Competitions

What to expect from your students

Often students will be a mixture of nerves and excitement for competitions. It can be a reasonably high-pressure situation for students, especially at first, but as students move to higher levels of the competition, students will often find themselves having much fun.

In Australia, competitions are always friendly, and while some healthy rivalries form, this is considered part of the competition and students learn to deal with the pressures involved. Overall, the competitions are a great learning experience for students and teams are encouraged to network with each other and share ideas to improve.

What's allowed and what isn't

During each competition, teacher involvement is not permitted. Of course, they can speak with their students and must make sure they're behaving safely at all times. Staff can give hints and tips at specific points, but when it comes to rectification, trade displays and judging panels, teachers are not permitted to intervene.

Students are allowed to rectify and work on their cars in the designated periods and are allowed to borrow equipment from other teams as long as they are given permission. While it is a competition, it's common to see teams helping each other out with suggestions and equipment such as glue.

Students must have media consent forms submitted with REA before any event. This is a part of the standard event registration process which registered teams will be reminded of before competitions. Students refusing to submit a signed Media Consent will not be permitted to attend an REA managed competition event.

Cars that are deemed unsafe by scrutineers and/or the chair of judges will not be permitted to race. Broken cars and loosely-fitted tether lines are two examples of cars that will not be raced.

Managing Expectations

The competition is all-encompassing in terms of the STEM outcomes. Students have to develop ideas, learn new concepts and apply them. All this while managing how they'll be acquiring sponsorship and meeting deadlines.

Expectations of students will be related to how you run the program. If you're running F1 in Schools across an entire cohort, then it might be appropriate to not overwhelm students at the start with the intricacies of the project and the work involved. With students who struggle to get motivated, once they're in the swing of things and if they're designing and producing good work, they will develop the motivation to find sponsorship and be proactive when they set their eyes on the competition.

On the other hand, if running F1 in Schools for students who are explicitly aiming to win a competition, that's great. With a smaller group of motivated students, it's a great idea to let them know the complete path and what's involved early on in the process.

It's really up to staff professional judgement when working with students within a school's individual context but managing expectations and determining realistic goals is certainly something to consider early on. Due to the nature of competitions, there can only be one winner, and it's important students (and teachers) learn to deal with this gracefully.

Sample Competition Results

Final results and awards are announced at all events. Following competitions, teams are provided with a full report on how they performed. In addition to the overall points summary, teams are given specific feedback from the judges on each of the judging areas.

As with all school assignments, it's very useful for teams to be aware of the judging criteria ahead of the competition. The following is an example taken from the result sheet provided to teams.

Judging Category	Low	Median	High	Your Score
Specifications	30	62	78	**65/80**
Engineering CAD	5	34	54	**54/65**
Engineering CAM	27	33	51	**51/65**
Engineering Design Process	18	43	59	**44/70**
Marketing - Project Management	6	46	64	**50/80**
Marketing - Portfolio Design	13	37	48	**37/50**
Marketing - Branding	25	41	56	**56/60**

33. Competition Costs

Trade Booth

In the Development and Professional Classes, Teams must organise and set up a trade booth to display their work. The cost can vary from $200 to $2000+, and it's really up to teams how they go about it this and how far they take their design.

Judges don't consider the costs involved in building the display but will examine how the students applied creativity and practicality to the set-up. Of particular importance are issues of sustainability and use of recycled products in the construction.

Team Uniform

Teams competing in the Development and Professional Classes do well if they can include in their marketing the development of a team uniform. In the early stages of the competition, a school uniform may be adequate. In higher levels of competition, team uniforms play a more important role in differentiating teams. They also provide an opportunity to display sponsors logos and bond the team together. Uniforms are usually outsourced and can cost from $30 per item.

Portfolios

The Development and Professional class are required to produce team portfolios. Portfolios can be printed inhouse or outsourced to an organisation like Officeworks. Portfolio printing can cost anywhere from $100 to $400+ depending on the quality and number printed. Cadet teams are only required to produce a poster.

Excursions/Industry Visits

Mentoring of students by industry adds value to the knowledge the students can discuss with judges. We recommend that teams arrange site visits to industry to help build their knowledge and understanding of the world of work. REA can assist any school who would like to visit industry which provides support to the Defence Industry via our relationship with the Department of Defence. In the past, we have seen teams work with a wide range of exciting and sometimes obscure industries and organisations. Collaborating with industry is an invaluable source of knowledge, and can open opportunities for sponsorship

34. Competing Team Costs

State & National Final Registration Fees

Costs are involved in the State, National, and World Finals to cover the provision of display booths and event costs. When teams are ready for these levels of competition, they should have a plan to raise money and manage these costs on their own. Describing how they manage project costs is a component of their enterprise portfolio. The cost of team transport and relief teachers would also need to be considered by the school to allow attendance at these more significant events. The cost involved in participation is available on the REA website: https://rea.org.au/f1-in-schools/fees-and-registration/.

The following are an estimate of the participation costs for a State & National Final:

- State Finals (Cadet)- $200
- State Finals (Professional and Development Class) - $475
- National Finals - $975

If your school is taking on F1 in Schools for the first time or if you have a large number of students, it would be a good idea to whittle down the teams within your school who will attend State level competitions. .

Costs and Involvement of Time

F1 in Schools is an extensive program in terms of the possible learning pathways which may come from involvement. There is no upper limit to the learning process, and Teams will need to produce a large amount of content to comply with the judging criteria. They will look to access knowledge from may areas including engaging with industry, Universities and TAFE along the way. Chasing sponsors can also be a time-consuming activity. The students should manage the additional financial resources needed to undertake these activities.

Funding and Sponsorship

Fundraising is scary work which is not usually within the vocabulary of teachers or students. Fundraising requires persistence, determination and resilience. There will be many knockbacks, but these should feed the desire to try again.

Students will need to take responsibility for raising the funds they need for their project which might involve making application with the school's P&C, run fundraising activities, a BBQ at a Bunnings or applying for a grant from the Federal or State Government. It's up to students to chase down sponsorship and develop relationships with local organisations.

To assist with the process of fundraising, teams should develop a prospectus outlining the Return On Investment (ROI) that sponsors will receive from their investment. This document should be relevant to the industries they will be approaching and the local environment.

NOTES:

1. From our experience, it is remarkable how easily students can attract sponsors. Each year we take four teams to the World Finals, and the cost of this can be as high at $60,000. We have never had a team that was not able to attract sufficient sponsors. In some cases, they have attracted over $90,000 per team in sponsorship which has allowed the school to use the additional support for the purchase of equipment.
2. Success at F1 in Schools can help lift the image of the school, assisting schools to develop long term relationships with industry, attract industry as sponsors and mentors to guide students career pathways.

35. Creating a STEM HUB

Why Create a STEM HUB?

Fostering a culture of collaboration, learning and understanding is one of the best outcomes that the F1 in Schools program has to offer. Providing students with the tools and opportunity to create and produce will empower students to see the world differently and look through a lens of creativity and innovation. It will provide your students with the where-by-all to become producers rather than consumers in the world we live in today.

Creating a STEM Hub won't suddenly turn students into engineering experts, but it will allow both students and teachers to push their limits and allow them to grow without the barrier of accessibility.

What is a STEM HUB?

A STEM HUB is a modern-day industrial design workshop: a creativity factory where student ideas can come to life. Students might be creating a simple new toy for themselves or a sibling or a well-engineered solution to a problem. Regardless of what they want to produce, a STEM hub allows students to use the tools they learn from different subject areas across the school and to apply them into a finished product.

A STEM HUB will allow them to create a tangible solution from a concept that originated in their mind. Students can be working towards a specific goal or freely innovating. As with most learning, a hand on STEM experience will also allow students to make mistakes and develop a greater understanding of what exactly goes into producing any designed solution.

STEM HUB Equipment

A stem hub can contain a range of technologies which will allow students to design and create almost anything.

3D Printers

More recently, 3D printing has been recognised as providing learning outcomes by placing in the students' hands what was in their minds. 3D printing is only one of the steps in the design process along the way to producing an outcome. Using 3D printing in industry started 25 years ago where its use was as a design aid and not a result. While learning outcomes can come from 3D printers, they are still subject to bad data in = wrong model out.

Ideally, an excellent 3D printer will be a part of a STEM Hub, but it should only be one of many elements that make up a STEM hub.

CNC Router

For a school looking to implement F1 in Schools, a quality CNC router is an ideal addition to a STEM Hub. REA offers Denford CNC equipment to Australian schools. A CNC Router is perfect for any STEM Hub as it produces designed solutions via subtractive manufacturing techniques, as used in industry, consistently and reliably. Denford CNC Equipment is designed specifically for schools - the software is easy to use, and the machines are very robust. The Denford Routers machine with precision and speed, which is ideal for in-class use for projects beyond F1 in Schools.

F1 in Schools Race Track & Equipment

Schools that go all-in on F1 in Schools can achieve great results. Purchasing an F1 in Schools track or timing equipment and an Air Trace Visualisation Tunnel provides students with an opportunity to test their cars and analyse their efficiency in-house. They are an effective way to engage all the students in the school and demonstrate student success in the program. Having a track onsite makes racing very accessible to students and provides a platform for high schools to engage and link with the feeder primary schools in their region. Schools can host race days, where they invite primary students to their school, host engagement activities with parents which helps support the transition of primary students to high school.

A track can also facilitate a range of projects and in-class activities beyond F1 in Schools. A range of track options are available which fit with any school environment.

36. Equipment Costs

Race Tracks

Purchasing a race track is a good place to start. Track and Launch systems start at just under $6,000 f which can be set-up on a gymnasium or auditorium floor. An elevated track and launch system costs just under $12,000.

In most cases, a track isn't necessary to compete in the competition. If you have a large number of teams within your school, you might need a track to determine which teams do go on to a regional or state final. Depending on your location, it might be possible to use a track at a neighbouring school or to borrow or hire a track. Please contact REA if you wanted to look into either of those options.

Of course, a track is a great motivator for students, and we would recommend having a track on-site.

Testing Equipment - Smoke Tunnels

While the best way to test a car's speed is to test on a track, there are ways to refine a design and make it more aerodynamic. A smoke tunnel is one of those ways. When it comes down to the finer details, Smoke Visualisation System is a great way to go. A Smoke Visualisation System, from around $4,200 can bring the world of aerodynamics into perspective for students. It allows students to see aerodynamics in real-time. To see how air moves around their F1 car and what is holding their car back from going faster. It can be used on many projects outside of F1 in Schools and is a tool that engages students quickly and visually.

Manufacturing Equipment - CNC and 3D printers

If you want to manufacture your team cars on-site, a CNC milling machine is required along with a 3D printer.

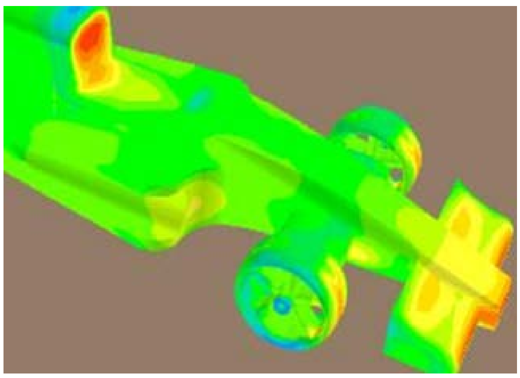
Our Denford machines start at around $16,000 and are ideal for F1 in Schools. You can still run the program without a CNC machine, however, it will require outsourcing the manufacturing to local industry or nearby schools.

Your School may already have a 3D printer, but if not, a high-quality machine starts at approximately $5,000. Cheaper 3D printers are likely to cause more problems than they are worth.

Virtual Wind Tunnel Software

Virtual Wind Tunnel Software can be an invaluable tool in analysing a car's design before manufacture. This can be a great addition to any CAD package as it is compatible with STL files produced from any CAD platform. The software starts from just under $600 for a single seat, with a site licence costing $1,550.

CHAM



37. Teacher Feedback

The following feedback comments were provided by participating teachers in response to questions posed in an annual survey implemented by REA

1. **Have REA programs changed the perception of STEM education in your School? If yes, in which way?**

- It is a very comprehensive program, gives a real experience on deadlines and teamwork. Students can see how these skills relate to the real world. (Wesley College, WA)
- Being a low socio-economic school with a high rate of refugee students, it has become a wonderful program to open their minds to the possibilities. (Balga Senior High School, WA)
- It broadens students horizons. One student has actively changed his career direction because of F1 in schools. Students realise that stem education has an engineering component which has high status in the community. (The King David School, VIC)
- It has changed the perception of staff that subjects should operate as isolated silos, to being a perception that subjects need to be inter-related and collaborative. (Gold Coast Christian College, QLD)
- It is great to have very clear structure to project-based learning projects. The different levels allow us to cater to different needs. (Provides) real-world problems and skills not just paddle pop sticks. (Ulladulla High School)

2. **Have REA programs increased the adoption of STEM and/or engineering studies at your school? If yes, in what ways has it brought about a change?**

- (Through implenting F1 in Schools, our) current stage five and six engineering studies student (numbers are the) highest in years. (Plumpton High School)
- The majority of students studying science or engineering at HSC level have completed REA programs in year nine and 10. (Ulladulla High School)
- It's hard to pinpoint in statistics, but students engaged in STEM and REA events are more involved and enjoy their studies more. (Parramatta Marist College)
- It is the most comprehensive STEM project. Students enjoy all the different aspects. We try and make stem projects comprehensive like the F1 in Schools program. (Wesley College, WA)

3. **What are the learning outcomes for the students as a result of participating in REA's Programs?**

- Huge learning outcomes, students are working within a rigourous criteria on a broad range of lifelong skills. (Alamanda K-9 College, VIC)
- To develop teamwork to deliver a project based on inquiry and relative to real life. To develop skills for life long learning. To acquire manufacturing and have skills developing and demonstrating their knowledge of technology. To utilise numeracy and literacy skills to enhance their project. (Albert Park College, VIC)
- Dynamic problem-solving skills, time and resource management, teamwork, leadership qualities. (Port Hacking High School, NSW)
- It's hard to put this into a little box, however, my view is that students need to understand that REA program, F1 in schools, is their opportunity to be their best. They have a great chance to represent the school in a healthy atmosphere of competition and success. Wonderful pathway to their adulthood. (The King David School, VIC)

4. **What are the positive aspects of REA Programs which stand out for you?**

- You are technology. CAD, allows students to extend themselves, allows students with different skill sets to participate to a high level. (Adelaide High School, SA)
- The fact there is a role for all students, regardless of where they lie on the technical, people centred spectrum. (Blue Mountains Grammar School, NSW)
- F1 in Schools really helps students to mature and helps them understand the skills that they will need for the future. It encourages collaboration, communication and develops lifelong learning skills in a positive (way). (Albert Park College, VIC)

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Re-Engineering Australia Foundation Ltd
ABN: 12 095 876 323
Unit 7/20-22 Foundry Road
Seven Hills NSW 2147 Australia
PO Box 136, Castle Hill NSW 1765
Phone: +61 (02) 9620 9944 Int. Facsimile: +61 (02) 8079 0622 Email: contact@rea.org.au
Internet: www.rea.org.au