



in Schools
Ireland

TEACHERS' GUIDE 2020-2021



What is the F1 in Schools STEM Challenge?

The F1 in Schools STEM Challenge is a global multi-disciplinary competition, open to all secondary schools in the island of Ireland. It challenges secondary school students to design, build and race miniature compressed air-powered Formula One cars of the future. Student teams will compete against each other in a National championship to determine Ireland's best engineered car, Ireland's fastest car, and Ireland's National Champions. The challenge inspires students to use IT to learn about physics, aerodynamics, design, manufacture, branding, graphics, leadership, teamwork, media skills, finance and communication, while applying them in a practical, exciting and competitive way.

Design will play a critical role in the success of your teams– both in the design of the car itself and the people involved in bringing that design from the initial idea right through to the race-track. Team members must be carefully chosen and trained to work together, use cutting edge engineering software and the latest in manufacturing technology.

Although the challenge is primarily STEM-based, the most successful teams nationally and globally are those who utilise marketing and business techniques to raise sponsorship funds and create recognisable team identity. Students are encouraged to use software tools to manage their projects and to develop a project website and social media presence to communicate how their designs evolve

The competition runs throughout the **first half of 2021**, culminating in the **Irish National Final in April 2021**. National Champions, Runners Up and Third Place teams will all be invited to travel to Singapore to compete at the F1 in Schools **World Finals in September 2021**

Who Runs It?

F1 in Schools Ireland is managed by Student Innovation Ireland, a not-for-profit company comprised of award-winning F1 in Schools World Final alumni and STEM advocates.

“F1 in Schools gives students the opportunity to engage with science and engineering in a fresh, exciting and dynamic context. The competition is accessible for all students yet provides a competitive element that accelerates skills development. F1 in Schools sparked my own interest in engineering, which has lead to a career in medical device innovation”

Aaron Hannon- F1 in Schools Ireland National Director and World Finalist, 2015



Why has the Challenge Been Introduced?

F1 in Schools aims to help change inaccurate perceptions of engineering, science and technology and enterprise by creating an exciting learning environment for young people to develop informed views about careers in these disciplines

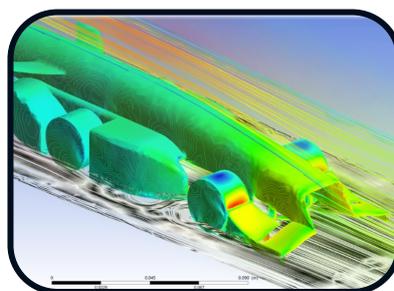
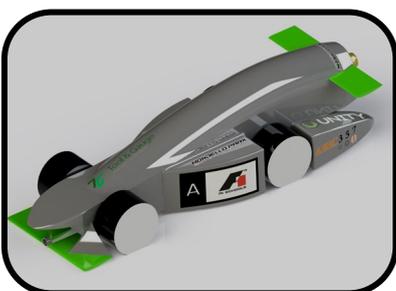
CAD/CAM, CNC and VR systems are now in the engineering industry, which is why it is so important for the engineers and designers of the future to familiarize themselves with such software early on in their careers.

F1 in Schools allows and encourages students to experience new and advanced technologies that they wouldn't have otherwise, and to test themselves against the very best Ireland has to offer. Technologies students should use through the development of their car include:

- **Computer Aided Design (CAD)** encourages students to think, explore and visualise their ideas in three-dimensional space, using features such as complex curve modelling and surface rendering, alongside for traditional orthographic presentations
- **Computer Aided Manufacturing (CAM)** packages create an environment where CAD designs can be prepared for manufacturing processes. Most CAM packages allow manufacturing processes to be simulated before they're carried out
- **Computational Fluid Dynamics (CFD)** software allows CAD models of car designs to be analysed, with regard to aerodynamic performance, to identify areas for improvement based on drag or turbulence.
- **Computer Numerically Controlled (CNC)** machines allow processed CAD/CAM models to be manufactured to high degrees of accuracy, fit and finish.
- **3D Printing** allows students to develop rapid prototype car components, to explore how they interact together in real life. Modern 3D printers on high-accuracy settings also allow for the production of end-use car components such as wheels, nose cones and rear wings.

Although all software and manufacturing needed to complete the challenge is provided free at www.f1inschools.ie or www.f1inschools.com, students are encouraged to establish links with third-level establishments or industry to gain access to more advanced tools for the design, development and production of their car

Through direct experience of the technology and processes required to complete this project, it is hoped that more students will be encouraged to explore and/or pursue a career in STEM sectors, or perhaps in an actual Formula One team!



Key Steps

Business Plan

Form a team and assign roles. Register and download resources at www.f1inschools.ie and start brainstorming. Develop a brand, draft a budget and create ways to raise funds.

Design

Use CAD software to start bringing your design concepts to life. Ensure to read the technical regulations before designing.

Analyse

Test car designs both virtually and physically with Computational Fluid Dynamics, Wind tunnels and Test tracks.

Make

Use methods such as CNC machining and 3D printing to produce manufacture and then assemble the race car. Teams will be allocated a manufacturing partner if their schools do not possess the necessary CNC machinery.

Pit Display and Portfolio

Design and build a pit display, to showcase the team's identity, and more importantly, their hard work on competition day. Produce two portfolios which document the car's design and engineering process, and the team's enterprise.

Race

Race against other competitors, to determine who has engineered Ireland's fastest car.

How are the Teams Organised?

- Each team must have between three and six students
- Each school can enter as many teams as they wish
- Each team member should be assigned one or more of the following roles: team manager, resource manager, design engineer, manufacturing engineer, graphic designer, marketing manager, sponsorship manager, graphic designer, communications manager.
- Each team should have one teacher coordinator
- All teams, regardless of year group/age will be competing in the one class. However, awards will be given to the highest scoring junior-cycle team.

How are Teams Judged?

- Specification Judging
- Enterprise Judging and Pit Display
- Design and Engineering Judging
- Verbal Presentation
- Racing

To see specific judging scorecards and the criteria needed to score highly, refer to the F1 in Schools Ireland Technical and Competition Regulations at www.f1inschools.ie

Timeline 2020-21

- **November 15th 2020:** Registration Deadline
- **December 11th 2020:** Submission of 5 Page Proposal Plan
- **January 31st 2021:** Submission Deadline for Manufacturing
- **Feb/March 2021:** Regional finals
- **April 2021:** Irish National Final

Team Prizes

Main Awards:

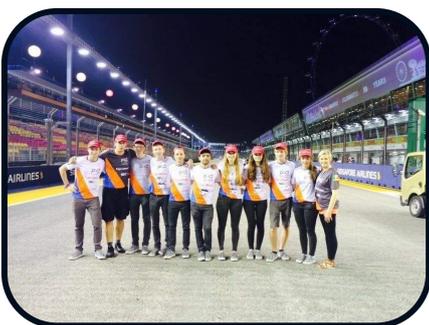
- Irish National Champions
- 2nd Place
- 3rd Place
- Fastest Car
- Best Engineered Car

Star Quality Awards:

- Research and Development Award
- Best use of ICT Award
- Enterprise Award
- Pit Display Award
- Sponsorship and Marketing Award
- Innovative Thinking Award
- Team Identity Award
- Judges Recommendation
- Knockout Racing
- Outstanding Sportsmanship
- Verbal Presentation Award

F1 in Schools World Finals

The top three teams at the National Final will be invited to represent Ireland at the prestigious F1 in Schools World Finals. This seven-day spectacle, which runs in conjunction with a Formula One Grand Prix, sees the world's top F1 in Schools teams compete for the title of World Champions, university scholarships, and coveted places on Williams F1 team's Engineering Academy. Previous locations have included Singapore, Abu Dhabi, Malaysia and Texas. World Final students will enjoy an experience of a lifetime, while greatly enhancing their career prospects.



Stage 1: Registration

Register your school for the F1 in Schools Challenge on our website (www.f1inschools.ie). You can keep updated by visiting our website regularly or viewing our Facebook or Twitter page for all the details and deadlines you need to know about the Challenge. In the registration process you will be asked for your personal email address, this is so we can forward you updated information on the competition. You will also be asked to enter the team managers email address, this is so we can also forward them information on the competition and that they can have their own login to the website to register the remaining team members. Teams must be registered by **15th November 2020**.

Stage 2: CAD Software

Check your school has access to a suitable 3D CAD software package. Note that the software must be able to meet the design and presentation criteria outlined in the Rules and Regulations. Many schools have received SolidWorks software through the T4 subjects (Design & Communications Graphics, Architectural Technology, Engineering Technology and Technology), this software is suitable for the competition. If your school does not have access to 3D CAD software for the Challenge, worldwide partners of F1 in Schools, AutoDesk, have kindly given us copies of their fantastic software to give to schools who participate in the challenge. Details on how to obtain your free copy of AutoDesk software from F1 in Schools is available on the website (www.f1inschools.ie).

Stage 3: Introducing the Challenge

There are a number of ways that the Challenge may be implemented in schools. In some schools groups of students get together and ask the teacher to allow them to register for the competition in other cases the teacher picks the students most interested. Organise any interested students into teams of 3-6, positively encouraging mixed gender groups. If the teacher wishes to include the whole class we would recommend that multiple teams of 3-6 are formed in class and work on designs in their own teams. Each school may enter as many teams as they wish. Attention should be brought to the relevant Rules and Regulations documents.

Stage 4: Design and Analyse

Your team must use 3D CAD (Computer Aided Design) software to produce their ideas and model them in 3D. CAD software templates and dimensions for the Official F1 in Schools Blocks and other useful components can be downloaded from the F1 in Schools websites (www.f1inschools.ie & www.f1inschools.com). When designing the F1 in Schools racing car, bear in mind that the extreme ends of the block must be left clear for attachment of the manufacturing jig fixtures. Again, ensure that the 2020/21 Irish technical regulations are read carefully. When designing the car, students must ensure that their geometry is manufacturable i.e. not too thin or complex.

Once designs are modelled with CAD, students should analyse them like real Formula One engineers. Free Autodesk CFD software can be obtained from www.f1inschools.ie. This software will allow students to analyse how their car behaves aerodynamically, and will allow them to determine whether design modifications should be made before manufacturing. Alternate CFD and simulation packages can be sought online, or through team partnerships with industry or higher-education. Students looking for a greater challenge may research into using Finite Element Analysis Software (FEA) to simulate the forces acting on their car and identify weak-points where breakages may occur.

Teams should also test experimental car parts, as well as the fully assembled car in the real world. In the past, students have developed experiments using home-made wind tunnels and test tracks to fine-tune their designs.

Stage 5: 5 Page Proposal Plan

****This step is NEW for the 2020-21 Season. 5 Page Proposal Plan examples will be made available at www.f1inschools.ie.**

The 2020-21 season will see the introduction of a “Qualifying Round” where teams will be asked to submit a 5 Page Proposal Plan by the **11th of December 2020**. This 5-page document should act as a method of engaging students in the project earlier in the academic year, as a method of encouraging students to develop a season-long project plan and as a mechanism by which the F1 in Schools Ireland team can understand the needs of participating teams better. This will allow our team to efficiently allocate resources such as mentors to participating schools. The Qualifying Round has been introduced in response to feedback from competing teachers and students. It is intended that the vast majority of teams will progress through the Qualifying Round. Much of the material presented in the 5 Page Proposal Plan should help form the basis of the Enterprise and Design Portfolio documents for the Regional Finals.

The Qualifying Round will be marked according to the guidance found below. Teams will be notified of their successful qualification for the Regional Finals before the Christmas break in 2020. Each team will be provided with individual feedback on the improvements that could be made, and the highlights of their application.

5 Page Plan				
	Low band	Middle band	High band	
Research and Design	Limited detail on research undertaken to date.	Basic research concepts outlined. Some evidence of sketching and CAD design development.	Several research concepts outlined with clear understanding and detailed explanations. Clear evidence of numerous design concepts being explored through both sketching and CAD.	
	1 2 3 4	5 6 7 8 9 10 11	12 13 14 15 16 17 18 19 20	
Team Structure	Limited detail on team structure.	Some evidence of roles and team planning (meeting agendas, charts)	Clearly defined and justified team roles linked to skills/interests. Strong evidence of teamwork and planning. Evidence of collaboration across tasks.	
	1 2	3 4 5 6	7 8 9 10	
Sponsorship, Budgeting and Project Management	Limited detail on sponsors and finance.	Sponsors and sponsor packages presented. Basic budget and spending plan. Spending not justified appropriately.	Excellent project plan with contingency and risk analysis, documented through Gantt Chart or similar. Sponsorships presented with clear return on investment. Detailed budget and spending plan with justified spending impact.	
	1 2	3 4 5 6	7 8 9 10	
Marketing and Brand	Some explanation of team name and brand colours. Social media handles.	Basic social media strategy presented. Justified explanation of team name and brand identity.	Clearly defined target audience. Advanced use of social media and online marketing to reach audience. Clear brand identity consistently shown throughout document, website (if applicable) and social media. Justified	
	1 2	3 4 5 6	7 8 9 10	
5 Page Plan Total =				/50

Stage 6: Manufacturing

****This step is designated manufacturing partners, if your school does not have access to a CNC router.**

When your students have completed their F1 racing car designs, the CAD drawings must be converted into a CNC program. The CNC program is formatted using standard G and M code language, used by CNC machines for plotting all their movement and cutting operations. CAM software packages can be used to help automate this process. Many schools do not have the machinery to manufacture their own cars and for this purpose we have teamed up with 'Manufacturing Partners', these are third level institutions who have agreed to participate and convert your teams designs to a CNC (Computer Numerical Control) program and manufacture them using CAM (Computer Aided Manufacture). CAM software turns 3D designs into X, Y and Z coordinates, the tool path that controls the movements of the 3-Dimensional routing machines cutting tool. You may wish to contact the partner whom we team you with if you wish to know more about the process. For example, will two separate CNC programmes need to be created – one for cutting the right side elevation of the F1 racing car, the second for cutting the left side elevation or will a 'mirror' command suffice. Certain Manufacturing Partners may request return on investment for their efforts, such as placing their logo on your team's car. To avail of this service, CAD files must be submitted to F1 in Schools Ireland before **January 31st 2021**

Note: the body of the car must be entirely manufactured from the Official F1 in Schools Model Block (made of dense foam), which will be provided by F1 in Schools Ireland and/or the Manufacturing Partners. For schools using their own facilities, the Official block can be purchased here: <https://isupply3d.com/F1-In-Schools/F1-In-Schools-Consumables>

Manufacture will occur in an F1 in Schools approved Manufacturing Centre. You will receive notice from F1 in Schools as to the location of your local Make Centre. If your school has a CNC machinery to produce the car body, you can create your own car, but please let F1 in Schools know (teams@f1inschools.ie). The 3D design files should be sent to a Manufacturing Partner electronically. F1 in Schools will send you on details of the person to contact in your relevant Manufacturing Centre, a deadline for submission on files to the Manufacturing Centre and the file type for your teams design to be submitted to Manufacturing Centre e.g. .stl, .step etc. The CNC programmes produced by your Manufacturing Partner will then be manufactured at the Manufacturing Centre. You may wish to arrange a visit to the college to see your designs being manufactured. If you intend to manufacture at your school, ensure your CNC machine meets the specification required for construction. Check against items such as your machine working envelope, maximum spindle speeds, available router bits etc. by referring to both your original CAD drawings and the parameters defined in your CNC program. You will also need to purchase or construct a jig fixture, to hold the F1 model block during machining. This will also make it much easier to configure any offsets, since the block can be accurately replaced in the machine working area. Remember, you will probably have to load and run a CNC program that machines one side of the car, then remove, revolve and replace the block, before loading and running the second CNC program that machines the opposite side. Offset configuration is the MOST important time to be accurate, since any mistakes at this point could easily damage your material or equipment.

For 2021, the F1 in Schools Ireland Manufacturing Centres are:

- University of Limerick, Limerick, Ireland
- Nissan Motor Manufacturing UK, Sunderland, UK

F1 in Schools Ireland will provide a central 3D printing service for teams who do not have access to 3D printers. Examples of car parts allowed to be 3D printed within the regulations include wheels, front nose structure and rear wings. However, this service will be limited to **one set of components per car**. Additional spares can be ordered, however this will not be covered by the registration fee, and will incur an additional cost equal to material and time expenses, payable to Student Innovation Ireland. This will be kept as low as possible to ensure fairness to all teams. It is highly recommended that teams use their own 3D printers if they have access to them, for further prototyping and development of the car.

Stage 7: Assembly and Finishing

Car components can be assembled using adhesive such as epoxy. More advanced teams may develop snap-fit fixtures which will allow parts to be replaced in-case of breakages, or for future design changes. Teams should produce simple jigs to ensure all parts align properly when being assembled.

- Finishing should involve the following steps:
- Smooth down the machined body with rough / medium grade glass paper.
- Finish using a fine grade glass paper.
- Apply a coat of sanding sealer if available. Sand lightly when dry.
- Apply several coats of paint (you may want to undercoat it first).
- Decorate the car body with decals and stickers

Note: All F1 in Schools cars must contain the Official F1 in Schools decal on either side of the car. This can be downloaded from the F1 in Schools website, if teams want to print them personally. If not, the decals will be provided to teams at all F1 in Schools Ireland competition events.

Only a limited amount of hand finishing of the body is allowed. Any major hand finishing (so that the geometry of the car is altered) may result in team disqualification. This will be at the Judges' discretion. We expect all F1 in Schools racing cars to be completed with a high quality paint finish, including the application of any graphics, sponsorship or liveries, where deemed appropriate. Ensure that any sanding or painting operations don't change the dimensions of the car to a point where it breaks a technical regulation by a small fraction and incur a points penalty.

Stage 8: Racing and Competition Events

Teams will first compete in Regional Finals in March, with dates and locations to soon be confirmed, depending on the number of teams registered in each region. The top teams from each regional stage will then progress to the National Final, to be held in Dublin in May 2020

Refer to the Irish Competition and Technical Regulations for 2020/21 (available to download from <https://www.f1inschools.ie/downloads>) for a full list of what teams must produce for submission/judging at regional and national finals.

Points Weighting



- | | |
|---|------------------------------------|
| ■ Engineering Drawings and Renders | ■ Quality of Car Finish |
| ■ Technical Regulation Compliance | ■ Design and Engineering Portfolio |
| ■ Enterprise Portfolio | ■ Team Identity |
| ■ Pit Display | ■ Verbal Presentation |
| ■ Marketing, Sponsorship, Digital Media | ■ Racing |

For additional information and resources, visit www.f1inschools.ie

- Read rules and regulations
- Access past competitors' portfolios
- Download free software
- Learn from Masterclass video series
- Watch the 2020 virtual national final

or email us:
info@f1inschools.ie



See you at the track!