FORMULA STUDENT TEAM GUIDE

Contents

1. Purpose of this Guide

While particularly relevant to new entrants, this Guide is intended to help all teams get the most out of the opportunities that Formula Student presents. Compiled with the assistance of universities that have been involved in Formula Student for several years, it provides help and advice in successfully starting a team, designing and building a race car, competing at the annual event, and using Formula Student as a learning and development exercise. It also describes the basic purposes and structure of Formula Student and gives some ideas for involvement in the initiative after graduation.

2. Purpose of Formula Student

Formula Student is the biggest and best of its kind in Europe. Run by the Institution of Mechanical Engineers (IMechE), in partnership with the Society of Automotive Engineers (SAE), it challenges university students to design, build, develop, market and compete as a team with a small single seat racing car. Formula Student is therefore about building future engineering talent, not just in the technical areas of design and manufacture, but in many of the management, marketing and people skills so vital in the modern world, across all sectors of employment.

It provides the students with a real-life exercise in design, manufacture and the business elements of automotive engineering. Through Formula Student, undergraduates develop experience, skills and professionalism as “hands on” engineers, with a keen awareness of the often competing pressures of performance, cost, safety, reliability and regulatory compliance. It teaches them all about team working, working under pressure and to tight timescales. It demands total commitment, lots of late nights, and many frustrations and challenges along the way, but the net result is the development of highly talented young engineers.

It is not the purpose of Formula Student to produce talented young engineers specifically for the motor sport industry. While clearly the initiative is highly valuable to those students who do wish to take up a career in motor sport engineering, the skills and experience it develops are designed to be relevant and valuable to a much wider range of high technology engineering industries and organisations. For Formula Student, the excitement and appeal of motor sport are the catalysts that help to open young minds to the world of possibilities that a career in engineering involves. Another key purpose of Formula Student, therefore, is to help universities to attract school children into their engineering degree programmes.

3. Structure of Formula Student

At its heart, Formula Student is the European incarnation of the American Formula SAE initiative. It is one of many events in a global Formula SAE series, the others being Formula SAE-East, Formula SAE-West and Formula Hybrid, all held in the USA, and Formula SAE Australasia (FSAE-A), held in Australia. Other International events include FS Germany, SAE Brazil, SAE India and SAE Italy.

3.1. Entry Classes

Since its inception in 1998, Formula Student has been specifically designed to provide as wide a range as possible of learning and development opportunities for students at all stages of their academic studies. Formula Student is unique, therefore, in accepting entries in five different classes, designed to allow students to experience the total cycle of Research, Design, Manufacturing and Development. It should be noted, however, that teams new to the competition can enter in any class.

Class 2: This is intended as the basic entry class for teams wholly new to Formula Student and Formula SAE style competitions. It is for projects either at the design and component/model validation stage or for teams that have progressed beyond initial design concepts into manufacture of complete vehicle systems (at least a chassis). In general, more complete vehicles are likely to score more points than less complete vehicles. Points are awarded for design, presentation and cost (details below). To encourage continuous learning and project development, teams competing in Class 2 in one year usually compete in Class 1 or Class 1A in the following year.

Class 1: This is for a fully constructed and running vehicle as defined by the Formula SAE rules ("first year vehicles"). Points are awarded for design, presentation, cost, acceleration, skidpad, sprint ("Autocross" in FSAE rules), endurance and fuel economy (details below).

Class 1A: This low carbon class was introduced to the 2008 Formula Student competition and is defined in the Formula Student Class 1A rules. Points are awarded for development, presentation, acceleration, skidpad, sprint ("Autocross" in FSAE rules) and endurance. Cost is not judged.

Table 1 presents a comparison of the different entry opportunities available at the three main Formula SAE series events.

Entry opportunities	Formula SAE	Formula SAE-A	Formula Student
Design concepts	No	No	Yes
Complete chassis	No	No	Yes
Running vehicle	Yes	Yes	Yes
Developed vehicle	No	Yes	Yes
Low carbon vehicle	No	No	Yes

3.2. Competition

For the purpose of the competition, the students are to assume that a manufacturing firm has engaged them to produce a prototype car for evaluation. The intended sales market is the non professional weekend autocross, hill climb or sprint racer. Therefore, the car must have very high performance in terms of its acceleration, braking, and handling qualities. The car must be low in cost, easy to maintain, and reliable. In addition, the car's marketability is enhanced by other factors such as aesthetics, comfort and use of common parts. The challenge to the team is to design and fabricate a prototype car that best meets the teams' production target. Each design is compared and judged with other competing designs to determine the best overall car.

The competition itself consists of two basic elements; the static and dynamic events. Entries in all Classes compete in the static events, while the dynamic events are only for fully running vehicles (those in Class 1 and Class 1A). Full details of all the static and dynamic events can be found in the SAE Rules, published each year on the Formula SAE website. There is a link to the SAE Rules on the Rules page of the Formula Student website. There are some additional or modified rules specific to Formula Student, which take precedence over the SAE Rules. These can also be found on the Rules page of the FS website. Further advice is given in the "Competing" section of this Guide.

The maximum points allocated to each event are:

Event	Maximum points available	
Static Events	**Class 2**	**Class 1 & Class 1 (A)**
Design	150	150
Presentation	100	75
Cost	100	100 (Not Class 1(A))
Dynamic Events		
Acceleration	75	
Skidpan/Figure 8	50	
Sprint	150	
Endurance	350	
Fuel economy	50	
Total	350	1000

4. Starting Out

The list of universities taking part in Formula Student grows each year. This section is intended to particularly help students and faculty members at universities that have not previously taken part, by providing advice and tips on how to put a team together.

The first and most important point to make is that Formula Student is much more than a technical engineering design and manufacturing exercise. Clearly the technical challenges involved will be significant, but it is likely to be the financial, people and organisational challenges that prove the most difficult and that should therefore be the priority areas for a new team to sort out early on.

It is also highly advisable for any students or faculty members considering starting a Formula Student team to make a preliminary fact-finding visit to the competition (held in July each year). This will provide the perfect opportunity to talk to other students and faculty people involved, see first hand what sort of work is required, and get a real feel for the excitement and commitment that Formula Student generates.

Financial Challenges

Precise figures are very hard to give, and will vary from country to country and from university to university, but a broadly typical figure for a top-line competitive Class 1 car is about £20,000 in direct expenditure. There are very few, if any universities that will happily hand over that sort of amount of cash each year, so sponsorship raising and cost efficiency (spending what resources you do have wisely) are key skills for any team to master.

It must also be pointed out, however, that cars can and are built on much tighter budgets and Class 2 certainly provides lower cost routes to starting out in Formula Student. Although there is probably a good correlation between expenditure and overall points scored at the event, the enormous value of Formula Student as an individual learning exercise is no less for students in cash-strapped teams than for those with higher budgets.

Sponsorship can be donations of parts, materials, services, expertise or money. Parts and materials are probably the easiest form of sponsorship to obtain, while cash is usually the hardest. Obtaining any kind of sponsorship requires proper planning, team working and sound marketing and customer care.

An effective sponsorship campaign will generally have the following characteristics:

• It starts early, at least a year before the competition, and is based on a realistic budget which includes all the costs involved and a clear understanding of how much sponsorship needs to be raised.

• It involves several team members, not just one or two.

• It involves sales skills, selling the excitement and value of your project.

• It involves good quality visual aids, e.g. car photos or drawings, group team photos, etc, so that sponsors can see what they are being asked to spend their money on.

• It recognises that sponsors are valued customers, ensures they are getting a return for their donations and keeps them involved and informed. Websites, emails, events and regular newsletters all help to keep sponsors informed and to maintain an ongoing relationship.

• It recognises that different sponsors have different objectives. For some it will be promoting their products and services in the hope and expectation that FS students will be making favourable supplier decisions for their employers after graduating. For others it will be getting “first in queue” access to high quality engineering students. For others it may simply be doing their bit to support the development of engineering, or for advertising and publicity, or for product development, or for a whole host of other reasons.

• It recognises that sponsors are busy people too, that they do not have time to waste, and that time and other resources spent on Formula Student projects are almost certainly going to be lower priority than the fee-earning work they do for their customers. Do your homework before approaching a potential sponsor – be clear how they can help you, how you can help them, and who to approach.

• It makes use of any professional help that’s available, e.g. a fund-raising office in the university. Recognise, however, that such people are unlikely to be willing or able to do the hard work for you, but they can provide guidance and advice to make your job easier.

• It recognises that an active Formula Student programme can help the university to attract students into its courses, can provide excellent media and PR opportunities, can improve links with local industry and can produce better qualified, more employable engineers. Universities do therefore have a major stake in your project and can be persuaded to make sufficient funding provisions to support it, but it’s important to think of them as a valued customer/sponsor too, in fact they are probably your most valued!

• It involves good record keeping, e.g. of companies that have been approached in the past, and good knowledge management, to ensure that fundraising expertise is continuously developed within the team, and does not suffer when key individuals graduate or leave.

People challenges

As with money, there are no hard and fast rules about how many people you will need, but a good guide is probably 8 – 16 dedicated and committed individuals for a Class 1 entry, with maybe 5 – 10 individuals being adequate for Class 2 and Class 1A. Again, as with money, teams can and have operated very successfully with more or less than these guidelines, though obviously having too few people is likely to mean too much work for those that are involved, and having too many can create problems with co-ordination and group dynamics.

A team that gets the most from its people will generally have the following characteristics:

• **Effective leadership:** Leadership is all about having, communicating and living a clear vision of what the team is aiming to achieve, and inspiring others to share that vision and to strive to achieve it with you. Different situations require different leadership strategies, and good leaders can identify what's appropriate at any given time. Good leadership skills can be developed, and there are plenty of text books and courses to help the effective team leader, so make use of them!

• **Good recruitment, selection, retention and succession policies:** Look to recruit from a wide variety of sources. Obviously you'll need mechanical and electrical engineers, but business, marketing, logistics, costing and many other specialists can all be useful. If you have more volunteers than you need, select appropriately, ensuring a good balance of ages, experience, skills and team roles. Accept that the demands of a Formula Student project will mean a certain degree of turnover, but do what you can to retain good people, by giving them realistic expectations, involving them, valuing their opinions, and giving them opportunities to contribute, learn and have fun at the same time. Make sure you have succession plans in place for when key people graduate or otherwise leave the team, and ensure that the chosen successors can step into those positions quickly and effectively.

• **Good team dynamics:** Good team working is absolutely vital. Do not assume that any group of highly skilled, well motivated and experienced individuals can work well together. A team full of "ideas people" who get bored half way through the practical implementation of those ideas will not be effective, however good the ideas, nor will a team of perfectionists, or people that love to work on the details without ever looking at the big picture. An effective team needs a good balance of personality types, and takes time to become effective. There are various management tools and models to help the team leader put together effective teams, e.g. Belbin's team roles and the Myers-Briggs Type Indicators.

• **A good safety culture:** Racing cars, and the processes that go into building and testing them, are dangerous. There is no such thing as absolute safety, but work with your faculty advisors to develop working practices and procedures that minimise the risks, take strong action against anyone acting recklessly or in contradiction of those practices and procedures, and regularly remind everyone that it only takes one serious injury to get your Formula Student team shut down permanently. Make use of driver training opportunities, such as the FS Driver Training Day in June, Go Karting and/or using previous Formula Student cars if available.

Organisational Challenges

Along with money and people, to be successful you'll need to have a wide range of organisational resources at your disposal. These will include:

• **Good relationships with your faculty advisors and university:** Good faculty advisors can help you in all kinds of ways. They will certainly have

technical experience and knowledge, but they can act as your friend, advocate and ambassador. They will know the best way to get things done, and who to approach, and how to get the resources you need. As has already been mentioned, the university has a major stake in your Formula Student project, so take the time to earn their respect, confidence and support.

• **Work space:** To manufacture, assemble and test all the components and car systems, your team will need dedicated space. Such space is often at a premium, with a variety of projects and activities competing for it and often having to share it. Use what space you have wisely, and respect the needs of others with whom you share.

• **Machine shop and welding facilities:** Whether these are on site or hired in from outside, you'll need to develop good working relationships with the people involved.

• **Good project management:** You do not just have to put together a team and build a car that works, you have to do it all in time to compete at the Formula Student event in July. That means you should think and act like a professional project manager, making sure all the individual tasks that need to be done get done in the right order, at the right time, to the right quality and to the right cost. Things will go wrong, team members, suppliers and sponsors will let you down at crucial moments. Be prepared for it.

5. Designing

It is not the intention of this section to give detailed advice on the design of a successful Formula Student car. Above all else, Formula Student is a learning exercise, so teams must learn what does and doesn't work for themselves. Instead, this section aims to provide some more general advice on the design process and the design aspects to which teams should pay most careful attention.

• **Read the rules:** You don't want to have to make significant last minute changes to your design to get it through scrutineering, so be certain of the legality of your design right from the start. The full rules can be accessed via the Formula Student web site, and the organisers are happy to advise teams on rules issues at any time.

• **Be realistic in your design goals:** Rookie teams rarely, if ever, win the competition, so don't build up expectations too highly. Establish what it is reasonable to expect to achieve up front, within the various financial, people, organisational and technical constraints that apply. Agree at the outset what you all want to get out of your Formula Student project, make sure they are achievable, and base your design on those goals. It might be to develop innovative new vehicle systems, or to simply gain hands-on experience of building a car, or to finish in the top ten, or a whole host of other perfectly acceptable objectives.

• **Keep it simple:** To be reliable and competitive, it is best to make things simple and lightweight. This is not at all easy, but it is worth putting the design effort in up front to achieve it. Simple designs are cheaper, easier to assemble, less likely to go wrong, involve fewer parts, fewer kinds of parts

and tend to weigh less. All of these things will make your car perform better, be easier to maintain and cost less.

• **Get the packaging right:** Make sure you include all the major and minor components you'll need in your design, and be satisfied that they can all be integrated together effectively. Start with the chassis – that's the package that everything must fit into. Focus particularly on your engine and powertrain dimensions, the location of your suspension points and the cockpit dimensions. Design the suspension around the rules and the tyres, design the chassis to accept the anticipated loads from those suspension points and to accommodate the engine and people expected to be in it. Make a simple full size mock up (in MDF, say) that can be used to ensure things fit with some elegance this may also prove a useful marketing tool to attract sponsorship etc.

• **Make the overall package as attractive as possible:** The concept of Formula Student is to produce a prototype vehicle for subsequent commercial sale. A good looking car is bound to get a more positive reaction from the judges than an ugly one!

• **Make the driver's job as easy as possible:** Make sure all your drivers will be able to sit comfortably, as low as possible, and operate all the controls easily, even at speed. Formula Student courses have lots of tight corners and no high speed straights, so a successful car will have exemplary handling characteristics, will turn into corners accurately and maintain good cornering speed. Make sure you design for appropriate camber, caster, Ackerman geometry, roll centres, etc. With limited experience it can be very difficult to know what you need but as long as you have sound reasoned argument behind your decision, you will not be heavily penalised (especially as a first entry) for choosing the wrong path simply through inexperience. Choosing the "correct" compromise is always very difficult but if you come up with what appears a valid solution but cannot demonstrate how you arrived at it you will score less than the above inexperienced team that can justify their "error". Transient conditions are predominantly most important.

• **Choose the right tyres:** The tyres are obviously critical to the vehicle's performance, taking as they do all the acceleration, cornering and braking forces. Base your design around the capabilities of your tyres. Again, it is understood that with little experience this can be difficult in practice.

• **Pay attention to detail:** This is of vital importance. Do not specify things that are larger or smaller, heavier or lighter or more expensive than you really need. Again, this is difficult to do without some experience/knowledge of loads involved. Be as rigorous with the design of your sprockets, half shafts, ball joints, pedals, cooling system, wiring loom, gear ratios etc, as you are with the more "major" systems and components. Remember that everything on a race car is there for a purpose and so if anything fails, it's likely to have serious consequences. Safety is of paramount importance and poor preparation can lead to non-finishes, or worse, an accident. Allow time to prepare the car when finished, many books outline these basic steps. Try to learn from others as their mistakes are equally as valid as your own and far cheaper to benefit from.

6. Building

Novice car builders always under-estimate the time it takes to get a vehicle running well. You cannot design, build, install and expect everything to work first time! You must allow enough time to design, redesign, redesign again, build, test, find something wrong, redesign, rebuild, retest etc. If you think something will take two days, it will probably actually take two weeks! This applies to every system, every component and every part. In fact most of the time you'll need will be spent on sorting out small, apparently minor, parts. Don't think you can allow 70% of the time for the major components (chassis, suspension, powertrain) and only 30% for all the other stuff – it's much more likely to be the other way around.

Another very common misconception, particularly for teams dominated by mechanical engineers, is that the electrical and electronic systems just need to be plugged in and they will work. Sensors have to be mounted somewhere, and they have to be mounted correctly to get a readable signal. It's important to allow for proper sensor mounting in your design and to start installing, tweaking and debugging the electronic systems as early as possible. Having some electrical engineers on your team will help enormously. Engine mapping is also a time consuming and difficult process, so budget plenty of time to get the engine to start, run and idle reliably when cold or hot.

Another very important factor to bear in mind throughout the design and build process is safety. Compliance with the rules should be seen as the minimum you need to achieve, not a target. If the judges, scrutineers and officials have any concerns about the safety of your car, they will not let it compete, even if technically it meets the rules. Do not compromise when it comes to the safety of your drivers, or the marshals and spectators.

7. Competing

7.1. Static Events

There are three separate components to the static events; Design, Presentation and Cost. All of the Judges are generally seasoned professional people, genuinely interested engineers who have themselves given up their time to help improve your learning experience. They will be critical but they will also value even heated discussion! They are there for you to learn from.

Design Event

The objective of the design event is defined in the SAE Rules as follows: "The concept of the design event is to evaluate the engineering effort that went into the design of the car and how the engineering meets the intent of the market. The car that illustrates the best use of engineering to meet the design goals and the best understanding of the design by the team members will win the design event."

To be eligible for the design event, teams in all Classes must submit a Design Report and Design Spec Sheet in the specified format before the deadline published on the Rules page of the FS website, usually about six weeks prior to the Formula Student Event. These documents give an opportunity for the

teams to explain their design philosophies and concepts and present evidence of the different analysis and testing techniques they have used, as well as providing material for the judges to use in their assessments of the design, and the team's understanding of the design, during the event itself.

Detailed information on the specific rules and judging criteria applicable to each Class is available via the Rules page of the FS web site. Advice and Feedback is available on the Important Advice webpage. Information on the conduct of the design event during the competition will be provided in an Event Handbook distributed to all competitors and published on the July Event page of the FS website.

The main purpose of the design event is for the team to demonstrate knowledge and reasoning. The judges will want to know why you have made the design decisions you have made, the thought processes you used and the understanding you have. You must demonstrate an understanding of what your design can achieve, and its limitations. The judges will want to see hard data to prove your points and plenty of pictures to help explain your design and your car's construction process.

Presentation Event

Competitors are to make a presentation to upper level executives of an imaginary manufacturer. The presentation should tie together all factors that would influence the marketability and manufacturability of their design. The technical aspects of the vehicle design should be presented to reinforce or support performance claims. The competitors should show an understanding of the marketplace and the targeted customer, and show how their design fits into its expected market. Competitors must convince judges that their prototype represents a profitable enterprise for the manufacturer. The key to convincing people is to tell them how/why you have come to your conclusions. The team that makes the best presentation (regardless of the quality of the car) will win the event.

Detailed advice is available on the Important Advice page of the FS website, but in essence the judges will be looking at the following aspects:

Content - Can you explain adequately and appropriately how the car meets the requirements of the imaginary customer (Design, Marketability, Manufacturing Feasibility, Profit potential)?
Organisation - Did the presentation follow a logical order starting from the customer's (manufacturing firm) basic concept and showing how you have completed the concept and met their goals?
Visual Aids - Were you using high quality visual aids and were there clear visual references to the car and the points you were trying top make?
Delivery - Was the delivery made clearly and in a strong, confident manner?
Questions - Did the answers show that the team understood the question as asked? Did they really understand the answer and did their answers inspire confidence?

Cost Event

The concept of the cost event is to obtain an accurate estimate of the cost of the car in a limited production. Each team will prepare a report of their car's cost to be evaluated by the cost judges. The report is in effect your cost proposal to the senior management of a company to get them to invest in your product line. The more information that you can supply to them, the more professional the look of your materials, the more likely the company may be willing to look at the product itself. Additionally, the teams will also prepare an electronic Bill of Materials and a detailed process description.

The Cost Report evaluates not only the cost of the car, but also the team's ability to prepare an accurate engineering cost estimate and know exactly how the vehicle would be built. It must be submitted before the deadline published on the Key Dates page of the FS website. The event can be divided into three separate sections - the cost report itself, visual inspection and process discussion. Further detailed advice on the scoring system and nature of the cost event is provided on the Important Advice page of the FS website.

7.2. Dynamic Events

Technical & Safety Scrutineering

Prior to taking part in any of the dynamic events, cars must first pass all stages of the technical and safety scrutineering process. This ensures they are in compliance with the rules. As well as a visual examination of the car, the process also includes a brake test, noise test and tilt table test. Full details are contained with the SAE and Formula Student rules, and will be given in the Event Handbook distributed to all competitors.

Inevitably, not all cars pass the scrutineering process at first attempt, so alterations and re-building becomes necessary at the event itself. To give your team the best chance of passing, and thus being able to compete in the dynamic events, you must pay careful attention to all aspects of the rules and safety guidelines. As a further aid, the following list describes some of the common problems encountered by the safety scrutineers:

• **Welding:** The chassis is the main component of the vehicle and must therefore be made to the highest standard. Poor quality welding will not be allowed to pass scrutineering.

• **Firewalls:** There has to be a non-flammable barrier between the driver and anything that could cause a fire or injure the driver, and it should extend above the driver’s head. Air intakes must be positioned well away from the driver, in case of back-fire.

• **Seat belts:** Belts should be fitted in accordance with manufacturers’ instructions and be suitable for both the tallest and shortest driver. The lap strap buckle should not come into contact with the seat shell.

• **Wheel mountings:** There should be a central boss to support the weight of the vehicle, while the wheel bolts simply clamp the wheels to the drive flange. Designs without a central boss force all the radial, axial, braking and traction

forces through the bolts, increasing the likelihood of wheels becoming detached. All wheel bolts and studs must use a positive locking system (not Loctite).

• **Brakes:** Master cylinder pushrods and calliper mountings must be positively locked into position. Brake fluid reservoirs should not be fitted in the drivers' compartment or near any hot surfaces.

• **Steering:** The steering system should operate smoothly and freely, and such that the track rods and steering arms cannot make an angle of greater than 180 degrees. The steering rack should keep the track rods in as straight a line as possible. The steering rack should be mounted with the teeth pointing downwards, or with rack gaiters fitted to both ends, to prevent the possibility of debris lodging in the teeth. Pinch bolts used to hold the column to the rack pinion should be long enough to pass at least 2/3rds of the way through the groove in the pinion. Set screws must not be used in this location.

• **Suspension:** If springs are fitted in the drivers compartment, some form of protection must be fitted to prevent driver injury by trapping or flying parts. Rose joints should be of aircraft quality, sized to carry the loads imposed, and installed to operate within the manufacturer's given parameters. Rose joints should not be forced to operate in a locked situation.

For safety reasons, and to avoid costly and embarrassing component failures, it is important that you develop a systematic and consistent way to check all the critical nuts, bolts, hose clamps, electrical connectors, etc., before each dynamic event. A written checklist for each vehicle system is useful in this regard. This should not be seen as an insult to anyone's intelligence or memory, it is a common sense structured aid. All aircraft run through checklists for a reason.

Acceleration Event

The goal of the Acceleration event is to measure the vehicle's maximum acceleration capability by measuring the total time required for the vehicle to travel a straight distance of 75m from a standing start on flat ground. The event is designed to focus on the vehicles engine performance and drivability, and on the suspension design characteristics for the ability to provide maximum tyre grip.

Skidpan/Figure 8 Event

Probably the nearest thing to the "idealised" steady state, the goal of the Skid Pad event is to measure the vehicle's maximum cornering capability by measuring the total time required for the vehicle to complete one left hand and one right hand circle. The event is designed to focus on the vehicles' suspension and design characteristics and tune-ability for maximum lateral grip, and minimise the effect of driver reflexes during transitional manoeuvres.

Sprint Event

The Sprint event is designed to test the car's manoeuvrability and handling qualities on a tight course without the hindrance of competing cars. The Sprint

course combines the performance features of acceleration, braking, and cornering into one event.

Endurance & Fuel Economy Events

The goals of the (combined) endurance and fuel economy events are to test the durability of the vehicles and determine their fuel efficiency. The dual nature of the event can lead to compromises, as a corrective mileage of 26-litres/100km is required to avoid penalties. The course layout and 22 km length of the event tests the vehicles' durability. There is also a mandatory stop, driver change and hot restart that really tests reliability, and the teams' ability to make changes to pedal positions, seats etc. efficiently.

8. Learning

Above all else, Formula Student is a learning exercise, not a motor sport event. One of its great strengths is that this learning applies not just to the students taking part, but to everyone involved. For the students, though, probably the biggest lesson from involvement in Formula Student is that engineering is an art, not a science. It is about identifying solutions and making good choices in an environment where you don't have all the information you need, and where there is no single "right" answer, but no shortage of wrong ones!

Involvement in Formula Student will be hard work for any team and any individual member of that team. It needs commitment, faith, energy and an ability to work miracles on an almost daily basis. But always remember the big picture – that the experience and knowledge you are gaining will make you a better, more readily employable professional.

9. Life after Formula Student

The value, enjoyment and excitement of Formula Student can't happen without the support of a small army of organisers, sponsors, judges, officials, marshals, etc. We all derive enormous satisfaction from knowing that Formula Student graduates find great jobs and deeply appreciate the opportunities that IMechE, SAE and all the sponsors and supporters have provided.

Recruitment of FS graduates is one of the main benefits for many sponsors, so all competitors are encouraged to submit their CVs to IMechE prior to the event.

A great way to show this appreciation, to help keep Formula Student growing and developing, and to continue to benefit from the learning opportunities it provides, is to volunteer to get involved in the running of the event. We are always on the look out for judges and officials. We also like to hear from recent FS graduates about what they are doing now, to use their career path as case study material to help promote the value of the initiative. FS graduates can also help enormously by promoting the initiative within their new companies, encouraging them to sponsor the event or get involved in a wide variety of other ways.

10. Recommended Reading

The following list gives details of books and other resources that are generally thought to be good sources of additional advice and information for teams entering Formula Student. The list is by no means exhaustive, and we would welcome suggestions for other resources to be added to the list. Please email fsfeedback@imeche.org with any suggestions.

"Organizing a Formula SAE Team" by Alan Gruner.
http://www.sae.org/students/fsae_organizingteam01.htm
"Pat D'Rat's FSAE Technical Instruction" by Pat Clarke.
http://www.sae-a.com.au/fsae/downloads/Tech_Guide_Article.pdf
"Introduction to Formula SAE Suspension and Frame Design" by Gaffney and Salinas.
http://web.umr.edu/~formula/library/sae_paper/saepaper.pdf
"Engineer to Win",
"Drive to Win: The Essential Guide to Race Driving"
"Prepare to Win: Nuts and Bolts Guide to Professional Race Car Preparation"
"Tune to Win: The Art and Science of Race Car Development and Tuning",
Books by Carroll Smith.
"Competition Car Suspension: Design, Construction, Tuning"
"Race and Rally Car Source Book",
Books by Allan Staniforth.
"Race Car Vehicle Dynamics"
Book by Milliken and Milliken.
"Race Car Dynamics for Students"
Seminar series by Claude Rouelle.