

2001 FORMULA SAE®

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2001 Registration Form/Statement of Compliance

2001 FORMULA SAE®

1. CONCEPT OF THE COMPETITION

1.1 Competition Objective

The Formula SAE® competition is for SAE student members to conceive, design, fabricate, and compete with small formula-style racing cars. The restrictions on the car frame and engine are limited so that the knowledge, creativity, and imagination of the students are challenged. The cars are built with a team effort over a period of about one year and are taken to the annual competition for judging and comparison with approximately 100 other vehicles from colleges and universities throughout the world. The end result is a great experience for young engineers in a meaningful engineering project as well as the opportunity of working in a dedicated team effort.

1.2 Vehicle Design Objectives

For the purpose of this competition, the students are to assume that a manufacturing firm has engaged them to produce a prototype car for evaluation as a production item. The intended sales market is the nonprofessional weekend autocross 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 manufacturing firm is planning to produce four (4) cars per day for a limited production run and the prototype vehicle should actually cost below \$30,000. The challenge to the design team is to design and fabricate a prototype car that best meets these goals and intents. Each design will be compared and judged with other competing designs to determine the best overall car.

1.3 Judging Categories

The cars are judged in a series of static and dynamic events including: static inspection and engineering design, solo performance trials, and high performance track endurance. These events are scored to determine how well the car performs. In each event, the manufacturing firm has specified minimum acceptable performance levels that are reflected in the scoring equations. The following points are possible:

Static Events

Presentation	75
Engineering Design	150
Cost & Mfg. Analysis	100

Dynamic Events

Acceleration	75
Skid-Pad Event	50
Autocross Event	150
Fuel Economy Event	50
Endurance Track Event	<u>350</u>
Total Points	1,000

1.4 Previous Formula SAE First Place Teams

Since the first Formula SAE competition in 1981, the following teams have taken home first place honors:

<u>YEAR</u>	<u>HOST</u>	<u>1st Place Team</u>
2000	Formula SAE® Consortium	Texas A & M University
1999	Formula SAE® Consortium	University of Akron
1998	Formula SAE® Consortium	Cornell University
1997	Formula SAE® Consortium	Cornell University
1996	Formula SAE® Consortium	University of Texas-Arlington
1995	Formula SAE® Consortium	University of Texas-Arlington
1994	Formula SAE® Consortium	University of Michigan-Ann Arbor
1993	Chrysler Corporation	Cornell University
1992	Ford Motor Company	Cornell University
1991	General Motors Corporation	Virginia Tech
1990	Lawrence Institute of Technology	University of Texas-Arlington
1989	University of Texas-San Antonio	University of Texas-Arlington
1988	Lawrence Institute of Technology	Cornell University
1987	University of Texas-Arlington	University of Maryland
1986	Lawrence Institute of Technology	University of Texas-Arlington
1985	University of Texas-Austin	University of Texas-Arlington
1984	University of Texas-Austin	University of Texas-Houston
1983	University of Texas-Austin	University of Texas-Arlington
1982	University of Texas-Austin	University of Texas-Austin
1981	University of Texas-Austin	Stevens Institute of Technology

2. ELIGIBILITY

2.1 Individual Participant Requirements

Eligibility is limited to students to insure that this is an engineering competition rather than a race. Individual members of teams participating in this competition **must** satisfy the following requirements:

(a) **Student Status:** Team members must be enrolled as degree seeking undergraduate or graduate students in a college or university. Team members who have graduated during the seven (7) month period prior to the competition remain eligible to participate.

(b) **SAE Membership:** Team members must be members of SAE. Proof of SAE membership is required at the event. Applications for membership will not suffice. **This process must be complete and all team member's membership numbers must be provided to SAE prior to the competition! Students must have their membership card, documentation of membership, or membership number present at the competition.**

COMMENT: Information on SAE Student membership can be found at SAE's website: www.sae.org

(c) **Liability Waiver and Insurance:** All on-site participants and faculty are required to sign a liability waiver upon registering on-site. Individual medical and accident insurance coverage is the sole responsibility of the participant.

2.1.1 Driver Requirements and Limitations

All drivers must have, and present proof of:

- (a) a valid driver's license and
- (b) medical and accident insurance coverage

No individual may drive in more than six (6) Formula SAE competitions.

2.1.2 Ringers Prohibited

In order to maintain the credibility of fair competition at Formula SAE, the Faculty Advisor must prohibit "ringers." A ringer is someone that has exceptional skills related to the competition (e.g., driver) who cannot be a legal member of the team but helps the team win points.

2.2 Vehicle Eligibility

The car must be conceived, designed, and fabricated by the students without direct involvement from professional engineers, automotive engineers, racers, machinists, or related professionals.

The student team may use any literature or knowledge related to car design and information from professionals or from academics as long as the information is given as a discussion of alternatives with their pros and cons. Professionals may not make design decisions or drawings and the Faculty Advisor must sign a statement of compliance, as given in the Appendix A-1, with this restriction.

SAE Collegiate Design Series competitions to provide direct hands-on experience to the students. Therefore, students should perform all fabrication tasks whenever possible. Winning is more related to engineering professionalism than to who crosses the finish line first.

2.3 Vehicle Eligibility Requirements

2.3.1 First Year Vehicles



A first year car is one that has not previously competed in Formula SAE. Cars with completely new frames are classified as first year cars. Photographic or other evidence may be used to determine whether the frame is new. If there is a question, it is the responsibility of the team to provide additional evidence that their frame is new.

2.3.2 Second Year Vehicles



A second year car is one that has previously competed in one Formula SAE competition. Second year cars are allowed in the 2001 competition provided they have been significantly modified from their first appearance. Photographic and design documentation detailing the modifications is required, along with a statement from the Faculty Advisor.

Penalties for insufficient redesign or insufficient knowledge by the team will be applied during the Design Event. Refer to Section 4.6.11, "Penalties for Insufficient Redesign."

2.3.3 Third Year Vehicles - Prohibited



Cars that have been entered in two or more previous Formula SAE competitions are prohibited.

Any team found to have entered a vehicle that has previously been entered twice will not be allowed to compete. Additionally, the will be required to submit photographic evidence of a newly built vehicle before registration will be accepted in future years.

2.3.4 Number of Vehicles

No school will be allowed to enter more than one vehicle.

2.4 Faculty Advisor

The Faculty Advisor must accompany the team to the competition but is not allowed to provide hands-on help to the team or serve as a team member during the actual competition. The Faculty Advisor will serve as a liaison between the team and the officials.

3. VEHICLE REQUIREMENTS & RESTRICTIONS

The following requirements and restrictions will be enforced by the judges through inspection. Noncompliance must be corrected and the car re-inspected before the car is allowed to compete in the performance events.

3.1 General Design Requirements

3.1.1 Body and Styling

The vehicle must be open-wheeled and open-cockpit (a formula style body). To protect the driver, there shall be no openings through the bodywork into the driver compartment from the front of the vehicle back to the roll bar main hoop or firewall other than that required for the cockpit opening. Minimal openings around the front suspension components are allowed.

3.1.2 Wheelbase and Vehicle Configuration

The car must have a wheel base of at least 1525 mm (60 inches). The wheel base is measured from the center of ground contact of the front and rear tires with the wheels pointed straight ahead. The vehicle must have four wheels that are not in a straight line.

3.2 Chassis Rules

3.2.1 Ground Clearance

Ground Clearance must be sufficient to prevent any portion of the car (other than tires) from touching the ground during track events.

3.2.2 Wheels and Tires

The wheels of the car must be 203.2 mm (8.0 inches) or more in diameter. The tires can be any size or type. Tire or wheel type, compound or size may not be changed after the static judging has begun. Tire warmers are not allowed. No traction enhancers may be

applied to the tires after the static judging has begun.

3.2.3 Suspension

The car must be equipped with a fully-operational suspension system with shock absorbers, front and rear, with usable wheel travel of at least 50.8 mm (2 inches), 25.4 mm (1 inch) jounce and 25.4 mm (1 inch) rebound, with driver seated. The judges reserve the right to disqualify cars which do not represent a serious attempt at an operational suspension system or which demonstrate unsafe handling.

3.2.4 Steering

The steering system must affect at least two wheels. The steering system must have positive steering stops which prevent the steering linkages from locking up (the inversion of a four-bar linkage at one of the pivots). The stops may be placed on the uprights or on the rack and must prevent the tires from contacting suspension, body, or frame members during the track events. Allowable steering free play will be limited to 7 degrees total measured at the steering wheel.

3.2.5 Brake Systems

The car must be equipped with a braking system that acts on all four wheels and is operated by a single control. It shall have two independent hydraulic circuits such that in the case of a leak or failure at any point in the system, effective braking power shall be maintained on at least two wheels. Each hydraulic circuit shall have its own fluid reserve, either by the use of separate reservoirs or by the use of a dammed, OEM-style reservoir. A single brake acting on a limited-slip differential is acceptable. The braking system must be protected with scatter shields from failure of the drive train or from minor collisions. Unarmoured plastic brake lines are prohibited.



3.2.5.1 Brake Over Travel Switch

A brake pedal over-travel switch must be installed on all cars. This switch shall be installed so that in the event of brake system failure such that the brake pedal over travels, a switch must be activated which will stop the engine from running. This switch must kill the ignition and cut the power to any electric fuel pumps. The switch must be arranged so that if the brake pedal is released or depressed a second time, the engine will not restart.



3.2.5.2 Brake Light



The car must be equipped with a brake light of at least 15 watts or equivalent, clearly visible from the rear. This light shall be mounted between wheel centerline and driver's shoulder level vertically, and approximately on vehicle centerline laterally.

3.2.6 Jacking Points

A jacking point which is capable of supporting the car's weight and of engaging the organizers' "quick jacks", must be provided at the rear of the car. The jacking point shall be:

- Oriented horizontally and perpendicular to the centerline of the car
- Made from round, 25.4 mm (1.0 inch) O.D. aluminum or steel tube
- A minimum of 300 mm (11.8 inches) long
- Exposed around the lower 180 degrees of its circumference over a minimum length of 280 mm (11 in)

The height of the tube shall be such that:

- There is a minimum of 75 mm (3 in) clearance from the bottom of the tube to the ground measured at tech inspection,
- With the bottom of the tube 200 mm (7.9 in) above ground, the wheels do not touch the ground when they are in full rebound.

3.3 Crash Protection



The driver must be protected from car rollover and collisions. This requires two roll hoops which are braced, a front bulkhead with crush zone, and side protection.

Newly built cars for the 2001 competition shall comply with the requirements of this section. Any car built to the requirements of Section 3.3 of the 2000 Formula SAE Rules (but which does not comply with Section 3.3 of the 2001 Formula SAE Rules) may only be entered as a second year car. All cars must meet these new requirements for the 2002 competition.

3.3.1 Definitions

These definitions apply throughout Section 3.3.



- a) Main Hoop
The main rollover protection (roll bar) near the driver

b) Front Hoop

Rollover protection (roll bar) in front of the driver

c) Frame Member

A minimum representative piece of tubing as defined by Section 3.3.3.2

d) Major Structure of Chassis

That portion of the chassis which is within the envelope of frame members or structure that meet the requirements of 3.3.3.2. The upper portion of the main hoop and its bracing are not included in defining this envelope.

e) Crush Zone

A deformable area forward of the major structure/ bulkhead of the chassis designed to absorb energy.

3.3.2 Safety Structure Equivalency

Vehicle designs, which protect the driver to an equal or greater extent than required, will be allowed, provided they have been judged as such by a technical review. Approval will be based upon the engineering judgement and experience of the technical judge.

The technical review is initiated by completing the Safety Structure Equivalency Form using the format given in Appendix A-1. The form must be submitted to the organizer no later than March 1, 2001.

3.3.3 Minimum Material Requirements

3.3.3.1 Main and Front Hoops



Material	Outside Diameter x Wall Thickness
Round Mild Steel Tube (SAE 1010, 1015, 1020, 1025)	25.4 mm (1 inch) x 2.4 mm (0.095 inch)
Alternative Steel Tube	See Section 3.3.3.3
Aluminum Tube	See Section 3.3.3.3

a) Both the main hoop and front hoop must each be formed of one continuous piece of closed section tubing.

b) A 4.5 mm (0.18 inch) inspection hole must be drilled in a non-critical location of both the main hoop and the front hoop to allow verification of wall thickness.

- c) No composite materials are allowed for the main hoop or the front hoop.

3.3.3.2 Side Impact, Roll Hoop Bracing, Front Bulkhead

Material	Outside Diameter x Wall Thickness
Round Steel Tube	25.4 mm (1 inch) x 1.65 mm (0.065 inch)
Non Ferrous Metal	See Section 3.3.3.3 or 3.3.3.4
Composite Material	See Section 3.3.3.4



3.3.3.3 Alternative Tubing - Requirements

Alternative tubing geometry and/or materials may be used. The material must have;

- a) Equivalent yield strength in the “as-welded” condition (Reference: WELDING ALUMINUM (latest Edition) by the Aluminum Association, or THE WELDING HANDBOOK, Vol . 4, 7th Ed., by The American Welding Society)
- b) Equivalent Buckling Modulus EI (where, E = modulus of Elasticity, and I = area moment of inertia about the weakest axis)
- c) Minimum Wall Thickness Allowed

Material	Minimum Wall Thickness
Steel Tubing (Front and Main Roll Hoops)	2.1 mm (0.083 inch)
Steel Tubing (Roll Hoop Bracing, Bulkhead)	1.65mm (0.065 inch)
Steel Tubing (Side Impact)	1.25 mm (0.049 inch)
Aluminum Tubing	3.175 mm (0.125 inch)



The teams must submit calculations demonstrating equivalence for energy dissipation, yield and ultimate strengths in bending, buckling and buckling modulus, and tension, for the material in the as-welded condition. Submit the completed Safety Structure Equivalency Form per Section 3.3.2

Should aluminum tubing be solution heat treated and age hardened to increase its strength after welding, the team must supply sufficient documentation as to how the process was performed. This includes, but is not limited to, the heat treating facility used, process applied, and fixturing.

3.3.3.4 Non-Ferrous Materials - Requirements



If any other material is used, the team must present documentation of material type e.g. purchase receipt, shipping document or letter of donation, material properties.

The team must also submit calculations demonstrating equivalence for energy dissipation, yield and ultimate strengths in bending, buckling, and tension. Submit the completed Safety Structure Equivalency Form per Section 3.3.2.

3.3.4 Roll Hoops



The driver's head and hands must be protected from contact with the ground in any roll-over attitude. This requires a main hoop (roll bar) near the driver and a front hoop. Refer to Figure 1 below.

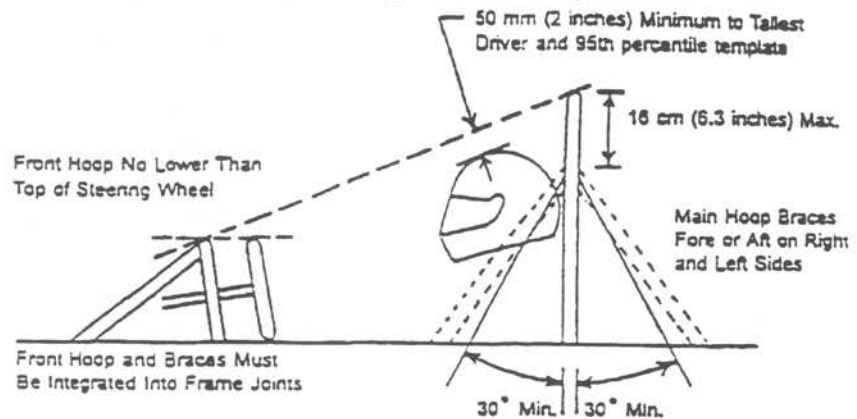


FIGURE 1

NOTE: Information on SAE steels can be found in the following SAE technical standards: SAE 1010, 1015, 1020 and 1025 - SAE J403, "Chemical Composition of SAE Carbon Steels"; SAE 4125 - SAE J1249, "Former SAE Standard and Former SAE Ex-Steels"; SAE 4130 - SAE J404, "Chemical Composition of SAE Alloy Steels"

3.3.4.1 Main and Front Hoops – General Requirements



- a) When seated normally and restrained by the seat belt/shoulder harness, a straight line drawn from the top of the main hoop to the top of the front hoop must clear by 50.8 mm (2 inches) both the tallest driver's helmet and the helmet of a 95th percentile male (anthropometric data).

A two dimensional template will be used to represent

the 95th percentile male and ensure compliance. The template dimensions are as follows:

- A circle of diameter 200mm (7.87 inch) shall represent the hips and buttocks.
- A circle of diameter 200mm (7.87 inch) shall represent the shoulder/cervical region.
- A circle of diameter 300mm (11.81 inch) shall represent the head (with helmet).
- A straight line measuring 600mm (23.62 inch) shall connect the centers of the two 200mm circles.
- A straight line measuring 150mm (5.9 inch) shall connect centers of the upper 200mm circle and the 300mm head circle.

With the seat adjusted to the rearmost position, the bottom 200mm circle will be placed in the seat, and the middle 200mm circle, representing the shoulders, will be positioned on the seat back. The upper 300mm circle, will be positioned up to 25.4 mm (1 inch) away from the head restraint (i.e. where the driver's helmet would normally be located while driving).

- b) The minimum radius of any bend, measured at the tube centerline, must not be less than three times the tube diameter.
- c) Both the main hoop and front hoop must extend to the bottom of the chassis. Each hoop shall be made of one continuous piece of tubing that extends from the bottom of the lowest frame member on one side of the car, up and over and down to the bottom of the lowest frame member on the other side
- d) Proper gussets and tube triangulation must be used to ensure that the main and front hoops are securely attached to the primary structure.

3.3.4.2 Main Hoop

- a) The main hoop must be constructed of material per Section 3.3.3.1.



- b) In the side view of the vehicle, the main hoop shall be within 10 degrees of the vertical.
- c) The vertical members of the main hoop must not be less than 380 mm (15 inches) apart (inside dimension) at their attachment to the chassis.
- d) On monocoque chassis the main hoop must be welded to mounting plates not less than 2.0 mm (0.080 inch) thick. These plates must be attached to the chassis in such a way as to spread the loads over a wide area. There must be a plate of equal thickness on the inside of the monocoque with solid rivets or bolts 8 mm (5/16 inch) minimum bolt diameter through the nonferrous material.



3.3.4.3 Front Hoop

- a) The front hoop must be constructed of material per Section 3.3.3.1.
- b) The front hoop must be no lower than the top of the steering wheel in any angular position.

3.3.5 Roll Hoop Bracing



3.3.5.1 Main Hoop Bracing

- a) The main hoop bracing must be constructed of material per Section 3.3.3.2.
- b) The main hoop must be braced in the fore or aft direction on the left and right sides.
- c) In side view, the main hoop and the main hoop bracing cannot be on the same side of the vertical, i.e. if the main hoop leans forward, the bracing must be forward of the main hoop, and if the main hoop leans rearward, the bracing must be rearward of the main hoop.
- d) Braces must be attached as near as possible to the top of the hoop but must not be more than 160 mm (6.3 inches) below the top and at an included angle of at least 30 degrees.



3.3.5.2 Front Hoop Bracing

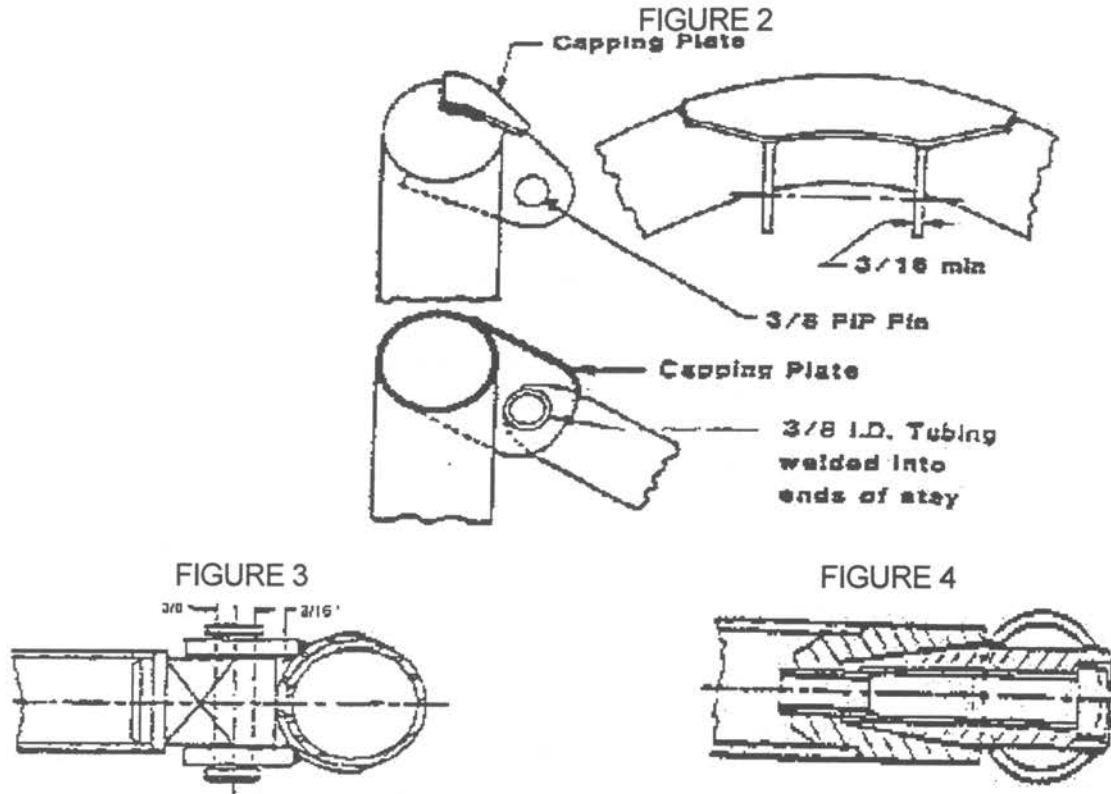
- a) The front hoop bracing must be constructed of material per Section 3.3.3.2.
- b) The front hoop must have two braces extending forward to protect the driver's legs.
- c) These braces shall be attached as near as possible to the top of the hoop, but must not be more than 50.8 cm (20 ins.) below the top of the hoop.
- d) The front hoop bracing should extend to the structure in front of the driver's feet; but in any case it must be integrated into the chassis to provide substantial support for the front hoop. When monocoque construction is used as bracing for the front hoop, it must be approved on an individual basis. Submit the Safety Structure Equivalency Form per Section 3.3.2.

3.3.5.3 Other Bracing Requirements



- a) Braces attached to monocoque chassis must be welded to plates not less than 2.0 mm (0.080 inch) thick and backed up on the inner side by plates of equal thickness using solid rivets or bolts 8 mm (5/16 inch) minimum bolt diameter through the nonferrous material.
- b) Roll hoop bracing may be removable but must incorporate connectors of the double-lug (Figure 2), muff-type (Figure 3) or tapered (Figure 4). NO SPHERICAL ROD ENDS are allowed. The double-lug type must include a doubler, gusset, or capping arrangement to avoid distortion or excessive strain caused by welding.

REMOVABLE ROLL BAR BRACES ATTACHMENT DETAILS (FIGURES 2,3,4)



3.3.6

Frontal Impact Protection – Drivers



In order to provide protection from a frontal impact, the driver's feet shall be contained within the major structure of the chassis. While they are touching the pedals no part of the driver's feet shall extend outside of the major structure of the chassis as defined in 3.3.1.d. The major structure of the chassis shall extend forward to a bulkhead. Forward of this bulkhead shall be a crush zone.

3.3.6.1

Bulkhead



The bulkhead shall:

- Be constructed of material per Section 3.3.3.2.
- Be formed of closed section tubing attached securely to the major structure of the chassis.
- Be in front of all non-crushable objects (e.g. batteries, master cylinders)
- Be located such that the soles of the drivers feet, when touching but not applying the pedals, shall not be forward of the bulkhead plane. (This plane is

defined as the forward most surface of the tubing.)
Adjustable pedals must be in the forward most position.

- e) Be supported by the major structure of the chassis within 5 cm (2 ins.) of the top. All monocoque chassis (composite monocoque or metal monocoque) must meet the same requirements as tube frames, per Section 3.3.3.2. The team must also submit calculations demonstrating equivalence for energy dissipation, yield and ultimate strengths in bending, buckling, and tension. Submit the completed Safety Structure Equivalency Form per Section 3.3.2.

3.3.6.2 Crush Zone



The crush zone is defined by two separated planes forward of the main chassis structure. The planes defined are normal to the fore/aft axis of the car.

a) Front Plane

The forward vertical plane of the crush zone shall, as a minimum, be able to contain a rectangle of 100mm (3.9inch) height and 200 mm (7.8 inch) width.

b) Rear Plane

The rearward vertical plane of the crush zone shall be the front plane of the Bulkhead.

c) Distance Between Planes

There shall be a minimum distance of 150mm (5.9 inch) between the front and rear planes of the crush zone.

3.3.6.3 Crush Zone Construction



The material providing the crush zone shall be attached securely and directly to the bulkhead (no adhesive tape or dzus type fasteners are allowed). It shall not be attached to the vehicle by being part of non-structural bodywork.

3.3.6.4 Non Crushable Objects



All non crushable objects (e.g. batteries, master cylinders) must be rearward of the bulkhead. No non crushable objects

are allowed in the crush zone.

3.3.7 Frontal Impact Protection – Others

Persons outside the car shall not be endangered by contact with sharp objects or protrusions on parts of the forward facing bodywork.

The minimum radius of the nose or other forward facing portions of the bodywork that could impact people shall be 38mm (1.5 inch). This radius shall be held to at least that value over the part of the nose or similar part within 45 degrees of the forward direction.

3.3.8 Side Impact Protection



The driver must be protected from a side collision while seated in the normal driving position. Side impact must meet the requirements listed below. The material requirements are given in 3.3.3.2.

3.3.8.1 Tube Frames



A minimum of three (3) frame members must be used for Side Impact Protection. These frame members must be located on each side of the driver while seated in the normal driving position. See Figure 5. The three (3) frame members defined below must meet the requirements given in 3.3.3.2.

Upper Frame Member

A frame member must connect the main roll hoop and the front roll hoop at a height between 200 and 350 mm (7.87 and 13.78 inches) above the ground with a 77kg (170 pound) driver seated in the normal driving position.

Diagonal Frame Member

At least one (1) diagonal frame member per side must connect the upper and lower frame members forward of the main roll hoop and rearward of the front roll hoop.

Lower Frame Member

A frame member must connect the bottom of the main roll hoop and the bottom of the front roll hoop.

Alternative geometry to the minimum requirements given above must be approved prior to competition. Teams must submit a Safety Structure Equivalency Form per Section 3.3.2.

3.3.8.2 Composite Monocoque

The section properties of the sides of the vehicle must reflect impact considerations. Non-structural bodies or skins are not adequate to meet the side impact rule.

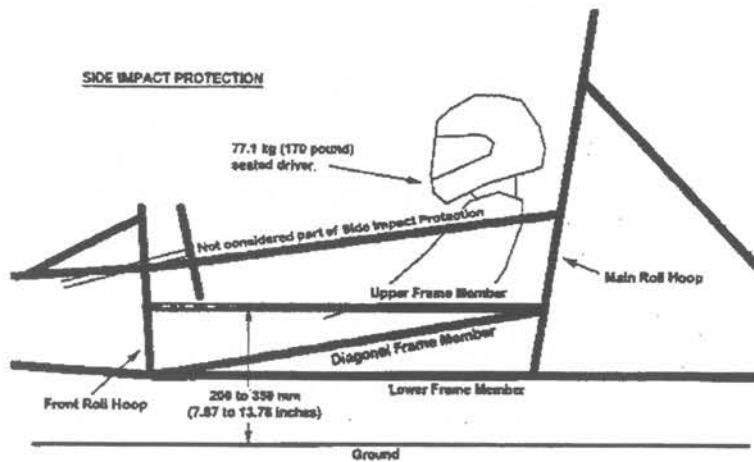
Teams building composite monocoque bodies must submit the Safety Structure Equivalency Form per Section 3.3.2. Submitted information should include: material type(s), cloth weights, resin type, fiber orientation, number or layers, core material, and lay-up technique.

3.3.8.3 Metal Monocoque

These structures must meet the same requirements as tube frames and composite monocoque. Teams building metal monocoque bodies must submit the Safety Structure Equivalency Form per Section 3.3.2

FIGURE 5

SIDE IMPACT PROTECTION



3.4 Safety - Driver Rules



3.4.1 Driver's Restraint System

All drivers must use either a five or six-point restraint harness meeting the following specifications. Arm restraints are also required. The restraint system installation is subject to approval of the SCCA Chief Technical and Safety Inspector. The restraint system must be worn as tightly as possible at all times.

a) 5 Point System

A five-point system, recommended for use in cars where the driver is seated in an upright position, consists of a 76 mm (3 inch) wide lap belt, approximately 51 mm (2 inch) wide shoulder harness straps, and approximately a 51 mm (2 inch) wide anti-submarine strap.

b) 6 Point System

A six point system, recommended for use in cars where the driver is seated in a semi-reclining position, consists of a 76 mm (3 inch) wide lap belt, approximately 51 mm (2 inch) wide shoulder harness straps, and approximately two 51 mm (2 inch) wide leg or anti-submarine straps.

c) Material Requirements

The material of all straps must be Nylon or Dacron polyester and in new or perfect condition. There must be a single release common to the lap belt and shoulder harness using a metal-to-metal quick-release type latch. All driver restraint systems must meet SFI Specifications 16.1., and must bear a dated "SFI Spec 16.1., Label," no more than five years old. It is recommended that driver restraint systems be replaced every three years.

d) Belt and Strap Mounting

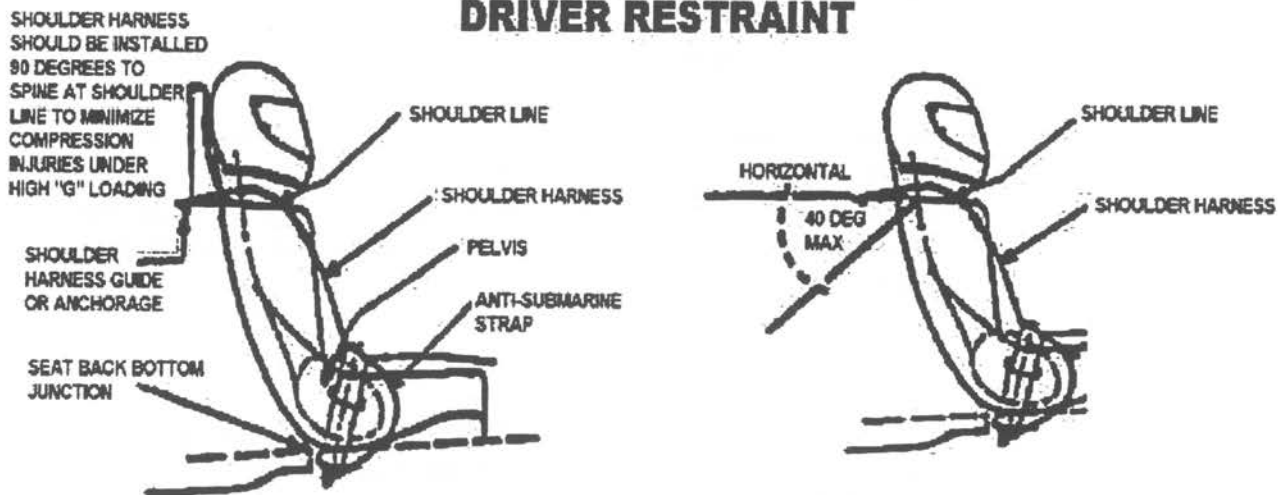
The lap belt, shoulder harness and anti-submarine strap(s) must be securely mounted to the primary structure of the car (i.e. frame tubes, roll structure). Such structure shall meet the minimum requirements of 3.3.3.2. Bolting through aluminum floor closeout panels, etc. is not acceptable. An SSE form must be completed for all monocoque structures (see 3.3.2).

e) Belt Position Requirements

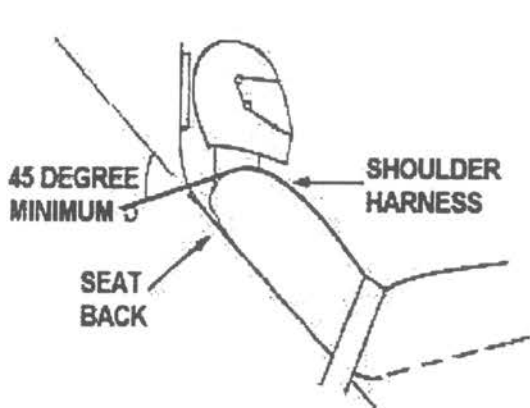
The lap belt must pass around the pelvic area below the Anterior Superior Iliac Spines (the hip bones) (Figure 6). Under no condition may the lap belt be worn over the area of the intestines or abdomen. The lap belts should come through the seat at the bottom of the sides of the seat to maximize the wrap of the pelvic surface and continue in a straight line to the anchorage point. The centerline of the lap belt at the seat bottom should be approximately 76 mm (3 inch) forward of the seat back to seat bottom junction (see Recommended Location in Figure 6).

The lap belts should not be routed over the sides of the seat. The seat must be rolled or grommeted to prevent chafing of the belts.

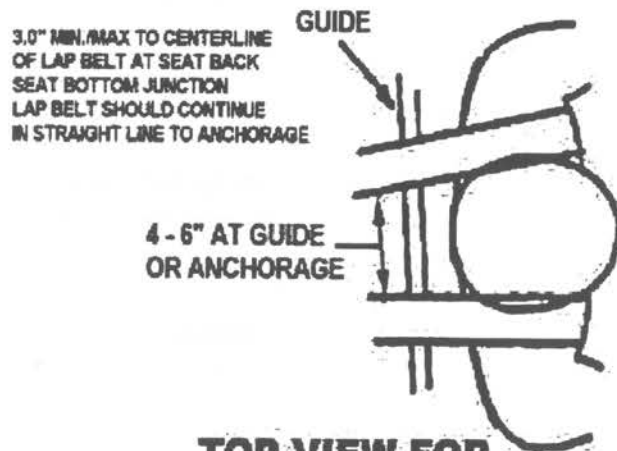
**FIGURE 6
DRIVER RESTRAINT**



UPRIGHT SEATED POSITION



SEMI-RECLINED SEATED POSITION



TOP VIEW FOR BOTH POSITIONS

f) Shoulder Harness

The shoulder harness must be the over-the-shoulder type. The shoulder harness must be mounted behind the driver and above a line drawn downward from the shoulder point at an angle of 40 degrees with the horizontal to minimize spine compression injuries under high "g" deceleration. In cases where the driver is in a semi-reclining position, the shoulder harness shall be attached so that the angle between a line drawn upward through the driver's seat back and the shoulder harness is 45 degrees or greater. Only separate shoulder straps are permitted (i.e. "Y"-type shoulder straps are not allowed). "H"-type configuration is allowed. It is recommended that the shoulder harness, where it passes over the shoulders, be 76 mm (3 inch) wide or have 76 mm (3 inch) wide padding. The shoulder harness straps must be threaded through the three bar adjusters in accordance with manufacturers instructions.

g) 5 Point System Anti-Submarine Strap

The single anti-submarine strap of the five-point system must be attached to the primary structure and have a metal-to-metal connection with the single release common to the lap belt and shoulder harness.

h) 6 Point System Leg Straps

The double leg straps of the six-point system may be attached to the primary structure or be attached to the lap belt so that the driver sits on them, passing them up between his or her legs and attaching to the single release common to the lap belt and shoulder harness. The leg straps may also be secured at a point common with the lap belt attachment to the structure, passing them under the driver and up between his or her legs to the harness release.

3.4.2 Driver Safety Equipment

The following equipment must be worn by the driver anytime the vehicle is moving under its own power or is running on a chassis dynamometer:

3.4.2.1 Safety Helmet

A well-fitting safety helmet with a Snell M90, SA-90, M95, SA-95, or British Standards Institution BS 6658-85 types A or A/FR rating. All helmets to be used in the competition must be presented during Safety and Technical Inspection where approved helmets will be stickered. The organizer

reserves the right to impound all non-approved helmets until the end of the competition.

3.4.2.2 Suit

A fire resistant suit that covers the body from the neck down to the ankles and the wrists. The suit shall be manufactured from one or more of the following accepted materials: Nomex, Kynol, FPT, IWS (wool), Fiberglass, Durette, Fypro, PBI, Proban and Kevlar. All suits must meet the SFI 3.2A or 1986 FIA standards and be labeled as such.

3.4.2.3 Gloves

Fire resistant gloves which are free of any holes. Leather gloves are not acceptable.

3.4.2.4 Eye Protection

Goggles or face shields, made of impact resistant materials.

3.4.2.5 Shoes

Shoes of durable fire resistant material, and which are free from any holes.

3.4.2.6 Arm Restraints

Arm restraints must also be installed on the car in a manner such that the driver can release them and exit the vehicle unassisted regardless of the vehicle's position.

3.4.2.7 Hair Covering

Hair protruding from beneath a driver's helmet shall be completely covered by fire resistant material, i.e. a Nomex balaclava or a full helmet skirt of accepted fire resistant material.

3.4.3 Driver Visibility

3.4.3.1 General Requirement

The driver must have adequate visibility to the front, rear and sides. The driver's head must be free to rotate 90 degrees to either side.

3.4.3.2 Mirrors

The car must be equipped with functional rear-view mirrors. Undersized or token mirrors are not acceptable.

3.4.4 Head Protection

3.4.4.1 Head Restraint



A head restraint must be provided on the car to limit rearward motion of the head in case of an accident. The restraint shall have a minimum area of 232 sq. cm (36 sq. inches), be padded, with a non-resilient material such as Ethafoam® or Ensolite® with a minimum thickness of 38 mm (1.5 inches), and be located no more than 25 mm (1 inch) away from the helmet in the uncompressed state. The head restraint must meet the above requirements for all drivers. The restraint, its attachment and mounting shall be strong enough to withstand a force of 890 Newtons (200 lbs. force) applied in a rearward direction.

3.4.4.2 Roll Bar Padding

Any portion of the roll bar or bracing which might be contacted by the driver's helmet shall be covered with styrofoam or other energy-absorbing material, minimum of 32 kg/m³ (2 lbs/ft³) polystyrene or equivalent, to a minimum thickness of 12 mm (0.5 inch).

3.4.5 Floor Closeout

All vehicles must have a floor closeout made of one or more panels which separate the driver from the pavement. If multiple panels are used, gaps between panels are not to exceed 3 mm (1/8 inch). The closeout must extend from the foot area to the firewall and must protect the legs and torso from track debris.

3.4.6 Steering Wheel

3.4.6.1 Circular Shape - Required

The steering wheel must have a near circular perimeter. "H", "Figure-8", or cutout wheels are not allowed.

3.4.6.2 Quick Disconnect - Required

The steering wheel must be attached to the column with a

quick disconnect. The driver must be able to operate the quick disconnect while in the normal driving position with gloves on.

3.4.7 Driver Egress

All drivers must be able to exit to the side of the vehicle in no more than 5 seconds.

Egress time begins with the driver in the fully seated position, hands in driving position on the connected steering wheel, wearing the required driver safety equipment. Egress time will stop when the driver has both feet on the pavement.

3.4.8 Roll Over Stability

The track and center of gravity of the car must combine to provide adequate roll-over stability.

3.4.8.1 Tilt Table Test

Roll-over stability will be evaluated using a pass/fail test. The vehicle must not roll when tilted at an angle of 57 degrees in either direction corresponding to 1.5 G's. The tilt test will be conducted with the tallest driver in the normal driving position.

3.4.9 Master Switch

The car must be equipped with two positive master switches affecting the entire electrical system of the car.

3.4.9.1 Switch Locations

One master switch must be located on the (driver's) right side of the vehicle, in the proximity of the roll bar at shoulder height, within easy reach from outside the car, and the other switch must be located for easy operation by the driver.

3.4.9.2 Master Switch Identification

The international electrical symbol of a red spark on a white-edged, blue triangle must be attached near both switches with the "off" position clearly labeled.

3.4.10 Fire Protection

3.4.10.1 Firewall



A firewall must separate the driver compartment from all components of the fuel supply, the engine oil and the liquid cooling systems. It must protect the neck of the tallest driver. It shall extend sufficiently far upwards and/or rearwards such that any point less than 100 mm (4 ins.) above the bottom of the helmet of the tallest driver shall not be in direct line of sight with any part of the fuel system, the cooling system or the engine oil system. The firewall must be a non-permeable surface made from a fire resistant material. Pass throughs for wiring, cables, etc. are allowable if grommets are used to seal the pass throughs. Also, multiple panels may be used to form the firewall but must be sealed at the joints to meet the intent of driver protection.

3.4.10.2 Fire Extinguishers

HAND HELD FIRE EXTINGUISHERS ARE NO LONGER PERMITTED TO BE MOUNTED ON OR IN THE CAR. However, as a team option, commercially available on-board fire systems are encouraged. Each team shall have at least one 0.9 kg (2 lb.) dry chemical 10BC or 1A10BC, 2 lb. Halon 1301 or 1211, AFFF, or CEA-614 fire extinguisher readily available in their paddock area. In addition, each team shall have a second extinguisher that will accompany the vehicle wherever the vehicle is moved. All extinguishers must be equipped with a manufacturer installed pressure/charge gauge, must meet the above specifications and must be presented with the vehicle at Tech Inspection.

3.4.11 Batteries

All batteries (on-board power supplies) must be attached securely to the frame or chassis structure. If located in the cockpit, wet cell batteries must be in a nonconductive, marine type container or equivalent. The hot terminal must be insulated on all cars.

3.4.12 Accessibility of Controls



All vehicle controls, including the shifter, must be accessible from inside the cockpit without any part of the driver being outside of any major structural members of the vehicle. An example of this is that arms may not reach around roll bar supports to operate the shifter of the vehicle.

3.5 Powertrain

3.5.1 Engine and Drivetrain

3.5.1.1 Engine Limitations

The engine used to power the car must be a four-stroke piston engine with 610 cc displacement per cycle or less. The engine can be modified within the restrictions of the rules. The organizer will measure or tear down a substantial number of engines to confirm conformance to the rules. The initial measurement will be made externally with a measurement accuracy of one (1) percent. When installed to and coaxially with spark plug hole, the measurement tool has dimensions of 381 mm (15 inches) long and 30 mm (1.2 inches) diameter. Teams may choose to design in access space for this tool above each spark plug hole to reduce time should their vehicle be inspected.

If more than one engine is used, the total displacement can not exceed 610 cc and the air for all engines must pass through a single air intake restrictor (see 3.5.4.2, "Intake System Restrictor.")

3.5.1.2 Transmission and Drive

Any transmission and drivetrain may be used. Exposed high-speed equipment, such as torque converters, clutches, belt drives and clutch drive, must be fitted with scatter shields of at least 12 gauge 2.67 mm (0.105 inch) mild steel (or documented equivalent ultimate strength and equivalent safety) to protect drivers, bystanders, fuel lines and safety equipment (such as brake lines) from flying debris in case of failure. Guards for finger protection may be made of lighter material.

3.5.1.3 System Sealing

The engine and transmission must be sealed to prevent leakage. In addition, separate catch cans must be employed to retain fluids from any vents for the coolant system and the crankcase. Each can must have a volume of ten (10) percent of the fluid being contained or 0.9 liter (one U.S. quart), whichever is greater.

3.5.1.4 Coolant Fluid Limitations

Water-cooled engines must only use plain water, or water with cooling system rust and corrosion inhibitor at no more than .015 liters per liter of plain water. Glycol-based antifreeze or water pump lubricants of any kind are strictly prohibited.

3.5.2 Fuel Allowed



During all performance events, the cars must be operated with fuel provided by the organizer at the event. These fuels will include 94 and 100 octane unleaded gasoline, and M85. Fuel specifications will be sent to all competitors in mid-January.

Nothing may be added to the provided fuels. This prohibition includes nitrous oxide or any other oxidizing agents.

3.5.2.1 Fuel Temperature Changes - Prohibited

The temperature of fuel introduced into the fuel system may not be changed with the intent to improve calculated fuel economy.

3.5.2.2 Fuel Additives - Prohibited

No agents other than fuel (gasoline or M85), and air may be induced into the combustion chamber. Non-adherence to this rule will be reason for disqualification. Officials have the right to inspect the oil.

3.5.3 Fuel System

3.5.3.1 Fuel Tank Size Limit

All gasoline fueled cars must be equipped with a fuel tank having a volume of no more than 7.57 liters (2 U.S. gallons). M85 fueled cars must be equipped with a fuel tank having a volume no greater than 13.25 liters (3.5 U.S. gallons). Any size tank may be used up to the maximum allowable size. The fuel system must have a provision for emptying the fuel tank for the purpose of measuring the tank volume.

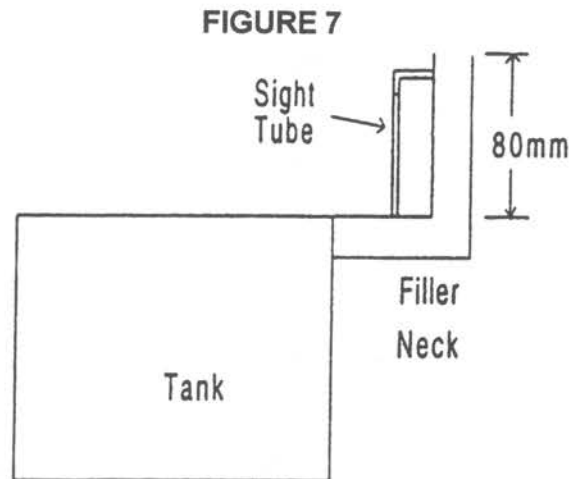
3.5.3.2 Filler Neck Size & Sight Tube

All fuel tanks must have a filler neck of at least 30 mm (1.2 inches) diameter and at least 80 mm (3.2 inches) vertical height. This 80 mm of vertical height must be above the top level of the tank, and must be accompanied by a clear fuel

resistant sight tube for reading fuel level (figure 7). The sight tube may not be run from the bottom of the fuel tank. A clear filler tube may be used, subject to approval by the rules committee or technical inspectors at the event.

3.5.3.3 Fuel Level Line

A permanent, non-moveable fuel level line must be located between 12.7 mm and 25.4 mm (0.5 inch and 1 inch) below the top of the sight tube. When filled to this level, the fuel system including fuel lines, filters, etc., must not hold any more than the maximum allowable fuel volume.



3.5.3.4 Tank Filling Requirement

The tank must be capable of being filled to capacity without manipulating the tank or vehicle in any way (shaking vehicle, etc.). The sight tube must be clearly visible to an individual filling the tank.

3.5.3.5 Spillage Prevention

The fuel system must be designed such that the spillage during refueling cannot contact the driver position, exhaust system or hot engine parts, or the ignition system. Belly pans must be vented to prevent accumulation of fuel.

3.5.3.6 Venting Systems

The fuel tank and carburetor venting systems must be designed such that fuel cannot spill during hard cornering or acceleration. This is a concern since motorcycle carburetors normally are not designed for lateral accelerations. During the inspection,



the car must be capable of being tilted to a 45 degree angle without fuel spilling from the carburetor or full gas tank. All fuel vent lines must be equipped with a check valve to prevent fuel leakage when the tank is inverted. All fuel vent lines must exit outside the bodywork.

3.5.3.7 Line Attachment and Protection

Fuel lines must be securely attached to the vehicle and/or engine. All fuel lines must be protected from possible rotating equipment failure or collision damage.

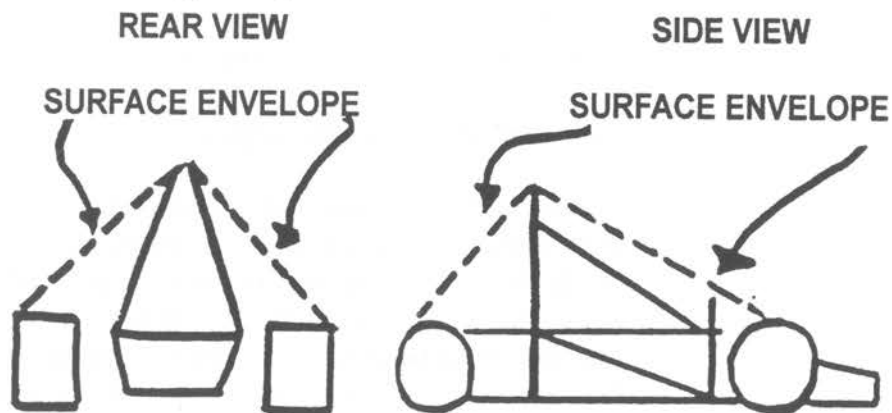
3.5.3.8 High Pressure System Requirements

High pressure over 103.4 kPa (15 psi) fuel systems must utilize protected hose (metal braided or some other abrasion resistant shielding) with either threaded fittings or modern OEM type fittings used without modifications to either the hose or the fitting. A hose clamp(s) over a removable line of any type is not permitted on a high pressure fuel line(s).

3.5.3.9 Fuel System Location Requirements

In order to prevent hazards in the case of a roll-over or collision, all parts of the fuel storage and supply system, and all parts of the engine air and fuel control systems that affect power (including the throttle or carburetor, but excluding air cleaner systems) must lie within the surface defined by the top of the roll bar and the outside edge of the four tires (see figure 8). All fuel tanks must lie within the major structure of the chassis as defined in 3.3.1.d.

FIGURE 8



3.5.4 Throttle and Intake Restrictor

3.5.4.1 Carburetor/Throttle Body - Required

The car must be equipped with a carburetor or throttle body. The carburetor or throttle body may be of any size or design. The throttle cable must have smooth operation and must not have the possibility of binding or sticking. The throttle actuation system must use at least two (2) return springs, so that the failure of any component of the throttle system will not prevent the throttle returning to the closed position. Throttle cables must be at least 50.8 mm (2 inches) from any exhaust system component and out of the exhaust stream. The use of a push-pull type throttle cable with a throttle pedal that is capable of forcing the throttle closed (e.g. toe strap) is recommended. A positive pedal stop must be incorporated on the throttle pedal to prevent over stressing the throttle cable or actuation system.

3.5.4.2 Intake System Restrictor

In order to limit the power capability from the engine, a single circular restrictor must be placed in the intake system between the throttle and the engine and all engine air flow must pass through the restrictor. Any device that has the ability to throttle the engine downstream of the restrictor is prohibited. The diameter of the restrictor must be no larger than 20.0 mm (0.7874 inch) for gasoline-fueled cars and 18.0 mm (0.7087 inch) for M85-fueled cars. The restrictor must be located to facilitate measurement during the inspection process. If the throttle exit (not venturi) or intake manifold (of a single tube through which all flow passes) has a diameter of equal or smaller than the restrictor, then a restrictor is not required.

If more than one engine is used, the intake air for all engines must pass through the one restrictor.

3.5.4.3 Turbochargers & Superchargers

Turbochargers or superchargers are allowed if the competition team designs the application. Engines that have been designed for and originally come equipped with a turbocharger are not allowed to compete with the turbo installed. The restrictor must be placed upstream of the compressor but after the carburetor or throttle valve. Thus, the only sequence allowed is throttle, restrictor, compressor, engine. Only ambient air may be used to cool an intercooler.

3.5.5 Muffler and Exhaust System

3.5.5.1 Muffler Required

The car must be equipped with a muffler in the exhaust system to reduce the noise to an acceptable level.

3.5.5.2 Exhaust Outlet

- (a) The exhaust must be routed so that the driver is not subjected to fumes at any speed considering the draft of the car.
- (b) The exhaust outlet(s) shall not extend more than 60 cm (23.6 inches) behind the centerline of the rear axle, and shall be no more than 60 cm (23.6 inches) above the ground

3.5.5.3 Noise

(a) Sound Measuring Procedure

All cars must pass the sound test before competing in any dynamic event. The sound level will be measured during a static test. Measurements will be made at 0.5 m from the end of the exhaust outlet with the microphone at the exhaust outlet level, at an angle of 45 degrees with the outlet in the horizontal plane. Where more than one exhaust outlet is present, the test will be repeated for each exhaust and the highest reading will be used. The test shall be run with the gearbox in neutral and the engine running at approximately 3/4 maximum rpm. The test rpm for a given engine will be the engine speed that corresponds to an average piston speed of 914.4 m/min (3,000 ft/min) for that engine, rounded to the nearest 500 rpm.. The test rpm's will be published by the organizers.

(b) Maximum Sound Level

The maximum permitted sound level shall not exceed 110 dBA, fast weighting.

(c) Sound Level Retesting

At the option of the judges, noise can be measured at any time during the competition. If a car fails the noise test, it will be withheld from the competition until it has been modified



and re-passes the noise test.

3.6 General

3.6.1 Car Number



Each car will receive a number at the time of its entry in the competition. This number must be displayed in 15.24 cm (6 inch), or larger, characters on the front and both sides of the vehicle. The numbers must be composed of white numerals on a black background, black numerals on a white background, or high-contrast equivalents. The use of metallic, fluorescent, or other reflective colors will not be approved.

3.6.2 School Name



Each car must clearly display the school name (or initials - if unique and generally recognized) in 5.08 cm (2 inch), or larger, characters on both sides of the vehicle. The characters must be placed on a high-contrast background.

3.6.3 Aerodynamics and Power Ground Effects

The purpose of the following rules is to minimize any likelihood of injury to spectators, officials, driver, etc. in the case of accidental contact with the wings and structure:

3.6.3.1 Wing Locations

The wing or wings must be located in plan view within a quadrilateral defined by the outside of the tires on the sides, by a transverse line 460 mm (18 inches) in front of the fronts of the front tires, and by a transverse line between the rear of the rear tires.

3.6.3.2 Driver Egress Requirements

Egress from the vehicle within the time set in section 3.4.7 "Driver Egress," shall not require any movement of the wing or wings or their mountings. The wing or wings must be mounted in such positions, and sturdily enough, that any accident is unlikely to deform the wings or their mountings in such a way to block the drivers egress.

3.6.3.3 Wing Edges - Minimum Radii

All wings: leading edges shall have a minimum radius 12.7 mm (0.5 inch) unless a wing projects in front of the front tires, in which case it must have a minimum radius of 19 mm

(0.75 inch). Wing leading edges must be as blunt or blunter than the required radii for an arc of plus or minus 45 degrees centered on a plane parallel to the ground or similar reference plane for all incidence angles which lie within the range of adjustment of the wing or wing element. If leading edge slats or slots are used, both the fronts of the slats or slots and of the main body of the wings must meet the minimum radius rules.

3.6.3.4 Other Edge Radii Limitations

All wing edges, end plates and wing accessories must have minimum edge radii of at least 3 mm (1/8 inch) i.e., this would mean at least a 6 mm (1/4 inch) thick edge.

3.6.3.5 Wing Edge Safety

No small radius edges may be included anywhere on the wings in such a way which would violate the safety intent of these rules (i.e. vortex generators with thin edges, sharp square corners on end plates, etc.).

3.6.3.6 Ground Effect Devices - Prohibited

No power device may be used to move or remove air from under the race car except fans designed exclusively for cooling. No power ground effects are allowed.

3.6.4 Fasteners

3.6.4.1 Grade Requirements

All bolts utilized in the steering, braking, safety harness and suspension systems must meet SAE Grade 5, Metric Grade M 8.8 and/or AN/MS specifications.

3.6.4.2 Securing Fasteners

All critical bolt, nuts, and other fasteners on the steering, braking, safety harness, and suspension must be secured from unintentional loosening. This can be accomplished best with safety wiring or cotter pinning; however, nylon lock nuts, locktight, and other forms deemed appropriate by the judges will be considered. Rod ends on the steering or suspension must be in double shear or captured by having a bolt head or washer larger than the diameter of the spherical bearing. Adjustable tie-rod ends must be constrained with a jam nut to prevent loosening.

3.6.5 Modifications and Repairs

Modifications to the car are not allowed after the inspection and engineering judging except as noted below. This includes modifications that affect the available gear ratios, power transfer system, or safety. The removal of body panels for weight reduction is not allowed. Adjustments (e.g., tire pressure, brake bias, suspension adjustments, wing angle, and chain or belt tension) are allowed to the car after the start of the performance events. Necessary repairs are allowed under the knowledge of the Faculty

Advisor and the car must pass a re-inspection by the inspection judges.

4. COMPETITION

The competition is divided into two categories:

- 1) STATIC EVENTS: Inspection, design, presentation and cost.
- 2) DYNAMIC EVENTS: Acceleration, skid pad, autocross, fuel economy and endurance.

Each of these events is described below in terms of the concept, how the event is conducted, the criteria used in judging, and the formula for scoring.

4.1 Weather Conditions

The organizer reserves the right to alter the conduct and scoring of the competition based on weather conditions.

4.2 Driver Limitations

An individual team member cannot drive in more than three events. The fuel economy event is considered a separate event although it is conducted simultaneously with another event. An individual may not drive in both heats of any event. It is the team's option to participate in any event. The team may forfeit their second heat in any performance event.

NOTE: A minimum of four drivers is required to participate in all heats of all the dynamic events.

4.3 Safety and Technical Inspection

4.3.1 Objective

The concept of the inspection is to insure that the safety and design requirements outlined in the rules have been met. For cases in which the rules are not perfectly clear, the intent of the rule must be met. Violation of the intent of the rule is considered a violation of the rule.

4.3.2 Inspection & Testing

Vehicle inspection will be performed at the time specified in the competition schedule.

In addition to the general inspection, the following specific tests will be conducted:

- Brake Check
- Sound Level (see 3.5.5.3)
- Intake Orifice Diameter (see 3.5.4.2)
- Roll Over Stability (57 degree Tilt Test)
- Fuel Leakage Test (45 degree Tilt Test)
- Wing and End Plate Radii (see 3.6.3)

4.3.3 Correction & Reinspection

The judges will complete the Safety and Technical Inspection, the Fuel Capacity and Tilt Table Inspection and the Noise Level and Braking Performance Inspection Check-lists in the Appendix as A-2. If the judges find any part of the car that does not comply with the rules or is deemed to be a safety concern, then the team must correct the problem and request a reinspection before the car is allowed to compete in any performance event. The inspection judges reserve the right to reinspect any of the specifications (particularly the brakes and muffler) at any time during the competition.

4.3.4 Non-Scored Activity

The inspection is not scored for team points; however, the car must pass the inspection and remain in accordance with the rules before it is allowed to compete.

4.4 Cost & Manufacturing Analysis Event

4.4.1 The Concept

The concept of the cost & manufacturing analysis event is to obtain an accurate estimate of the manufacturing cost of the car in limited production and assembled using lean manufacturing processes. This evaluates not only the cost of the car, but also the team's ability to prepare an accurate engineering and manufacturing cost estimate. The car with the lowest corrected retail cost, the best report and the best discussion of their process will win the event. **For a clarification of terms, see section 4.4.11. It is suggested that you read these items first.**

4.4.1.1 The Budget

Staying within a given budget is critical to the success of any "real life" engineering project (even professional race teams have finite budgets). Designing a great product that is over budget does not translate into a job well done. As such, the cost scoring has been devised to stress this important aspect of engineering. (Designing a great mousetrap is not nearly the challenge of designing the best mousetrap for a given amount of money.) The production run that you will base your process on must be able to build 4 cars a day for an unspecified number of days. **Costing for 1000 cars is no longer necessary.** The total **PROTOTYPE** cost of the vehicle will exclude R & D, capital expenditures (plants, machinery and tools). The prototype vehicle's **RETAIL** cost should not exceed \$30,000.00. If a team's retail cost exceeds this outer boundary, it will be disqualified from the cost event.

4.4.1.2 Deadlines

The deadline for submitting cost & manufacturing analysis reports is April 3rd, 2001. The submitted reports should include the cost report, the printed Bill of Material (and an electronic Bill of Material on disk), as well as a detailed process description for components and assembly. These reports should be mailed to: ***Attn: Suzy Zukowski, Team FSAE™ - DaimlerChrysler Corporation, CIMS: 483-01-14, 800 Chrysler Drive East, Auburn Hills, MI 48326-2757.*** It is imperative that the cost judges have the cost reports in enough time for proper evaluation. **Teams that submit reports late will be penalized -10 points per day late with a maximum penalty of -75 points.** Teams that do not submit a cost & manufacturing report will receive -100 points for the cost & manufacturing analysis score. The team must present

their vehicle at the designated time to the cost judges for review of the cost report or the penalty for missing the cost appointment is -20 points. The schedule for these appointments will be in the registration packets.

4.4.1.3 Addenda

An addendum that reflects any changes made after the submission of the cost report must be submitted at registration **only!** The single page addendum document must follow the template format specified in Appendix A-3. No other format will be accepted at registration.

4.4.2 Scoring



In the past, the focus of the cost & manufacturing analysis event has been to come up with the lowest cost vehicle. This quest resulted in many schools finding quotes on parts that may have been unrealistic in nature. This year, to de-emphasize this fictitious pursuit of the lowest cost components, we are endeavoring to change the focus of the cost event to manufacturing process and lean manufacturing assembly techniques. In order to do this, we are restructuring the points given for our event. The event is still worth 100 points, but these points will be broken down as follows:

100 Points total		
$25 \times \frac{30,000 - P_{your}}{30,000 - P_{min}}$	25 points	Lowest cost - each of the participating schools will be ranked by total adjusted retail cost from the BOM and given 0-25 points based on this ranking. [P _{your} is the adjusted cost of your car (with penalties), and P _{min} is the adjusted cost of the lowest cost car].
	15 points	The cost report - written professional presentation of cost data - The report score will be given based on the quality of the cost report. The range for the report score is 0-15 points.
	40 points	The engineering BOM (Bill Of Material) and the process breakdown - detailed description of how the parts would be manufactured using the material and operations cost tables. Assembly using lean manufacturing principles should include a general plant layout with complete assembly line layout, photos, graphics and prints are strongly suggested. The BOM itself needs to be in the form of an electronic spreadsheet (preferably in Excel). See Appendix A-5 for spreadsheet headings. 0-40 points.
	20 points	Visual Inspection/Event day - The cars would be reviewed for part content and manufacturing feasibility. The teams must be prepared to discuss in detail the overall lean manufacturing process, as well as concentrated discussion on the process used for 2 randomly chosen commodity areas of the vehicle. These commodities are found in Appendix A-4 . 0-20 points.

4.4.3 Cost Based on Production Rate

The Cost Event is judged on the basis of the cost of manufacturing the car, the detailed description of the manufacturing process, the engineering bill of material and the quality of the cost report. The cost of the car is determined by the cost of the components and vehicle assembly for a production rate of 4 cars per day using established lean manufacturing processes.

4.4.4 Requirements and Cost Penalties

The team will prepare a detailed engineering cost analysis and a detailed engineering Bill of Material using the guidelines given in Appendices A-4 and A-5. From this analysis, the cost judges will determine if all parts and processes were included in the analysis and if unreasonably low costs were used (determined by the experience of the judges). In the case of any omission, error, or cost below reasonable, the judges will add a penalty equal to twice the cost error. The team's retail cost plus penalties will be used to determine the cost score.

For example, if a car has tires listed at \$10 and the Cost Judges have evidence that the same or similar tires should actually cost \$50 then the judges will add 2 x \$40 for each tire to the cost. Errors of costs above reasonable prices are not penalized further and the error is not corrected. Cost reports that have not made a serious attempt at an accurate cost estimate or that claim to have a cost that is substantially below what the Cost Judges know to be appropriate for cars of this type will be disqualified as unresponsive and will be scored as unsubmitted.

The cost analysis for the car is based upon the estimated cost for materials, fabrication, and assembly of a car in limited production. The cost analysis should consider lean manufacturing assembly techniques that would be used in a limited production run. The actual production technique must be used on the prototype if at all feasible (e.g., cast parts should be cast on the prototype, etc.) Further, the parts used in the cost estimate must be the actual parts used on the prototype and substitution of cheaper parts for the cost analysis is prohibited. For example, if styled wheels costing \$150 each are used on the prototype, then substitute wheels costing \$50 each can not be used in the cost analysis. However, if you are using a purchased wire harness, all wires must be used or if they are not used, they should be removed from the harness. Any components on the vehicle will be assumed to be used in the production run and therefore must be costed. This includes but is not limited to: Data acquisition systems, radios, transceivers, t.v. sets, stereos, video games, cupholders, wet bars, etc.

4.4.5 Mandatory Report Format:

The Cost of the car must be itemized into sub-assemblies and follow the format in Appendix A-4 and A-5.

4.4.6 Bill Of Material:

4.4.6.1 Receipts

Retail costs for new parts only may be used. If a part is donated or discounted, a retail cost for said part must be given. The receipts should be numbered, labeled, and attached to each sub-assembly section with the quantities stated. Retail costs will include no discounts. The supplier/retailer's phone number must be included with each receipt. Costing based upon, and the use of, used parts in production is not permitted.

4.4.6.2 Format

The Bill of Material should follow the format found in Appendix A-5. If at all possible this BOM should be submitted in electronic form using Microsoft Excel on a single IBM compatible 3.5" disk or a CD Rom.

4.4.6.3 Component Manufacturing Process Costs:

Component costs consist of the material cost and process steps to manufacture a component. The time required to load, unload, machine, paint, fabricate, etc. is costed at \$35/hour if it is not explicitly costed from the Operations Cost Table. Do not include overhead costs of expendables, capital costs, and depreciation of machine equipment. The table given on the next page provides some guidelines to the cost of various operations. A detailed manufacturing process is required on all asterisked items listed in Appendix A-4, regardless of whether the item was purchased or manufactured on your team's vehicle.

4.4.6.4 Vehicle Assembly Cost - Applying Lean Manufacturing:

Develop a production strategy utilizing basic lean manufacturing principles. Include a calculated assembly cost as an individual line item at the end of the bill of material. The detail of the assembly process should be inserted in the cost report. It is helpful to your team to make "process flow charts" which organize assembly of your car to accurately identify all of

the costs of manufacturing. A line layout is strongly suggested.

4.4.7 Costing of Finishes and Fire Safety Items

4.4.7.1 Finishes

The car will be considered to be shipped as primed or gel coated and a cost recorded. Any finishes (paint, polish, etc.) which are only used to beautify need not be costed. Preservative finishes intended to protect the appearance or function of a component for an extended period of time must be costed (labor and material included).

4.4.7.2 Fire Safety Systems

Hand held fire extinguishers are not allowed on the vehicle (as per Fire Protection rule 3.4.10.2), but if the car has an on-board fire suppression system, it is not required to be costed.

4.4.8 Engine Costing

The cost of the engine depends upon the performance rating of the engine. The engine performance rating is based upon the power potential of the manufacturer's specification of the engine without restrictor modification. The engine is considered low performance if it is capable of producing less than 5 horsepower per 100 cc displacement (industrial engines, etc.). A high performance engine is capable of 5-10 horsepower per 100 cc (normal motorcycle engines with 2 valves per cylinder, etc.). An ultra high performance engine is capable of more than 10 horsepower per 100 cc (new high tech engines, 3- or 4-valves per cylinder, etc.). The engine is considered to be purchased with all of the required components and systems necessary to run. The engine costs listed below include the transmission/CVT device regardless of whether it is integral to the engine or not. Engines that come equipped with an integral transmission, differential, and U-jointed axles must estimate the cost of the differential and U-joints separately. Items driven by or beyond the general function of the engine and/or transmission must be costed. All other items: the carburetor (or fuel injection system), the ignition and/or electrical system (including spark plug(s), coils and wires), turbo or supercharger if used, the intake manifold, the exhaust manifold, cooling system (water & oil), and mufflers must be costed. These costs must be listed separately in the cost analysis.

The following table lists the costs of the engine:

RATING	ENGINE & TRANSMISSION/CVT
Low	\$ 0.60/cc
High	\$ 1.00/cc
Ultra-high	\$ 1.25/cc

4.4.9

COSTING TABLES

To assist in your process the following tables must be used in costing:

COMMON MATERIALS COST MINIMUMS TABLE	
Aluminum	\$0.75/pound
Chrome Moly.	\$0.60/pound
Graphite-based composites	\$220.50/kg (\$100/pound)
Magnesium	\$2.25/pound
Non-graphite composites	\$88.18/kg (\$40/pound)
Steel	\$0.30/pound

Other materials such as plastics span such a vast range of uses and costs that a common price standard is impractical. Cost for composites and structural construction similar to fiberglass should be costed separately with a **clear identification of the costs of all materials and processes**. Obviously, process costs are in addition to the above material cost minimums.

OPERATIONS COST TABLE	
Labor (all activity)	\$35.00 / hr.
CNC Machine (time)	\$70.00 / hr.
Welds	\$0.14 / cm (\$0.35/inch)
Saw or tubing cuts	\$0.16 / cm (\$0.40/inch)
Tube bends	\$0.75 / bend
Non-metallic cutting	\$0.08 / cm (\$0.20 /inch)
Tube end preparation for welding	\$0.75 / bend
Drilled holes less than 1" diameter, any depth	\$0.35 / hole
Drilled hole greater than 1" diameter	\$0.35 / inch / hole
Reamed hole	\$0.35 / hole
Tapping holes	\$0.35 / hole
Sheet metal shearing	\$0.20 / cut
Sheet metal punching	\$0.20 / hole
Sheet metal bends	\$0.05 / bend
Sheet metal stampings (process cost only)	\$0.008 / sq. cm (\$0.05 / sq. inch)
Sand castings (process cost only)	\$6.61 / kg (\$3.00 / pound)
Die castings (process cost only)	\$8.82 / kg (\$4.00 / pound)
Investment casting (process cost only)	\$17.64 / kg (\$8.00 / pound)
Plastic injection molding (process cost only)	\$6.06 / kg (\$2.75 / pound)

4.4.10 Examples of Process Descriptions

4.4.10.1 Purchase Example

The team purchased 3 widget "A's" from Amalgamated Auto for \$12 each on sale and they retail for \$15. No process need be written for this part, it does have to be listed in the Bill of Material (See the Appendix A-5, example #1).

4.4.10.2 Purchase and Alter Example

A component requiring detail process would be as follows - the team purchased 3 widget "A's" from Amalgamated Auto for \$12 each on sale and they retail for \$15. You altered each of them by cutting two surfaces on the mill @ 5 minutes each (A-5, examples #1 and #2).

Name: Widget A

Material

Sub.	Qty.	Desc.	Vol.	Weight	\$/Unit	Cost
A	3	Widget A			\$15.00	\$45.00
						\$45.00

Process Labor

Sub.	Qty.	Amt	Unit	Manning	Desc.	\$/Unit	Cost
A	3	10	Min.	1	Mill slot	0.583	\$17.50
						Total	\$17.50

4.4.10.3 Manufacture Example

The team purchased or had on hand a round piece of aluminum bar stock - 2" diameter x 7.5 "long. The piece was centered and cut on a lathe which was set up for production (would take 10 minutes) and milled in two slots (5 minutes each). Additionally, you drill four holes less than 1" in diameter and tapped two of them. The process sheet could look as follows (See Appendix A-5, example #3):

Name: Widget B

Material

Sub	Qty.	Desc.	Vol.	Weight	\$/Unit	Cost
A	1	Aluminum bar - round 2" dia, x 7.5" long	23.56 in ³	2.356	\$0.75	1.77
						\$1.77

Process Labor

Sub.	Qty.	Am't	Unit	Manning	Desc.	\$/Unit	Cost
A	3	10	Min.	1	Mill slot	0.583	\$17.50
						Total	\$17.50

Note: If widget "B" were a component such as an exhaust manifold, weld and fixture time would be listed here and not in final assembly. Each individual component and process would have its own sub number or letter assignment. The total component cost would then be added to the BOM as a single line item.

4.4.10.4 Off-Line Assembly Example

The team manufactured widget "C" and purchased widgets "D" and "E" (all of which are listed in the BOM) and assemble them at an offline assembly operation, it took 10 minutes. This is a final assembly cost and would be a part of the total assembly cost listed at the end of the BOM (See A-5, example #4). A breakdown of these costs is desired. The format of these costs may be determined by the team, but must be consistent across all items and have a total provided at the end. By maintaining an easy to follow, consistent format, the judges will be able to understand what the costs apply to, how they were derived and verify the team's assumptions.

4.4.11 Glossary of Cost Event Terms

- **Lean Manufacturing:** For the purpose of this event - Lean manufacturing is a tool used to eliminate waste from the final assembly process. The use of lean manufacturing is not required in the processing of individual components.

- **Line balance:** Effectively utilizing manpower or component placement at each assembly station to alleviate waste of time.
- **Manning:** The number of people needed to process, machine or assemble a component or perform a specific operation.
- **Prototype cost:** The actual RETAIL cost of all components purchased and manufactured (including material and labor for manufacturing the component) and all labor to assemble all parts into a whole. In the case of discounted or donated components, the retail price at which the component would be sold on the open market should be used.
- **Prototype:** The actual vehicle your team enters in the Formula SAE competition.

4.5 Presentation Event

4.5.1 Presentation Event Objective

The concept of the presentation event is to evaluate the team's ability to make a presentation to the customer. The presentation should address the "Concept of the Competition" as described in section 1, and should convince the customer of the superiority of the team's design. The presentation judges will evaluate the organization, content, and delivery of the presentation. The team that makes the best presentation (regardless of the quality of the car) will win the event.

4.5.2 Presentation Schedule

Presentation will be made on the first day of the event. The presentation time will be randomly selected and will be posted in conjunction with the organizational meeting held in the morning. A team will receive zero (0) presentation points if they fail to make their presentation during the allotted period.

4.5.3 Presentation Format

One (or more) team member(s) will give the presentation to the judging team. The organizer will provide details regarding the presentation in the newsletter. The presentation cannot last more than 10 minutes and should not be interrupted by questions. After the presentation, there will be approximately 5 minutes of questions. Only judges are permitted to ask questions. The audience may not ask questions or make any comments or distractions. During the question

period, team members are encouraged to answer questions.

4.5.4 Evaluation Criteria

The presentation judges will consider the content, organization, and delivery of the presentation and will only evaluate the team's ability to give a presentation. The judges will use the judging form given in Appendix A-6.

4.5.5 Scoring Formula

The scoring of the event is based on the average of the two or three presentation judging forms. There is a maximum of 50 points from the Presentation Judging Form.

$$\text{PRESENTATION SCORE} = 75 * P_{\text{your}} / P_{\text{max}}$$

It is intended that the scores will range from near zero (0) to seventy-five (75) to provide good separation.

4.6 Design Event

4.6.1 Design Event Objective

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.

4.6.2 Design Review Submission Requirement

Judging will start with a pre-event Design Review submitted before the event. This review should be a maximum of seven pages consisting of not more than four pages of text plus three pages of drawings(see 4.6.2.1, "Vehicle Drawings"). The review should contain a brief description of the vehicle with a discussion of any important design features and vehicle concepts. Include a list of different analysis and testing techniques (FEA, dynamometer testing, etc.). Evidence of this analysis and back-up data should be brought to the competition and be available, on request, for review by the judges. This pre-event review will be used by the judges to sort teams into the appropriate design groups based on the quality of their review.



4.6.2.1 Vehicle Drawings

The pre-event design review must include on set of 3 view



drawings showing the vehicle, from the front, top, and side.
Each drawing shall appear on a separate page.

4.6.3 Penalty for Non-Submission

Teams who do not submit a pre-event design review on time will not compete in the design event, and will receive zero (0) points for design.

4.6.4 Penalty for Unsatisfactory Submissions

Teams that submit a review, which is deemed to be unsatisfactory, will also not compete in the design event, but will receive between 5 and 20 pts. for their efforts.

4.6.5 Format Requirements

Reviews should be on 8 1/2 X 11 paper, in black & white and easily readable once faxed.

4.6.6 Submission Deadlines

Pre-event Design Reviews must arrive at SAE International no later than April 3, 2001. Send Design Reviews to:

**SHANIN HART
SAE EDUCATIONAL RELATIONS
400 COMMONWEALTH DRIVE
WARRENDALE, PA 15096-0001
FAX: 724-776-0890
E-MAIL: HART@SAE.ORG**

Mail and e-mail reviews are preferred, although faxed reviews will be accepted.

4.6.7 Design Event Format

The design event consists of an informal question and answer session between the team and the design judges. The design judges are encouraged to ask penetrating questions relative to the team's understanding and level of analysis of the car. Examples of questions are: stress levels, frame stiffness, Ackerman angles, bump steer, weight distribution, suspension curves, roll centers, rationale for design tradeoffs, etc.

4.6.8 Judging Criteria

The design judges will evaluate the engineering effort based upon the team's responses to questions and an inspection of the car. The design judges will inspect the car to determine if the design concepts are adequate and appropriate for the application (relative to the objectives set forth in the rules). It is the responsibility of the judges to deduct points on the design judging form, as given in Appendix A-7, if the team does not understand the engineering and construction of the car.

4.6.9 Judging Sequence

The actual format of the design event may change from year to year as determined by the organizing body. The event will normally involve three parts: (1) initial judging of all vehicles by 5 to 7 judging teams, (2) semi-final judging of the top 15 to 20 vehicles by 5 to 10 individual judges, (3) final judging ranking the top 4 to 8 vehicles.

4.6.10 Scoring

Scoring will be from 0 to 150 pts. At the judges discretion.

4.6.11 Penalties For Insufficient Redesign

The judges will deduct 20 points from the final design score for cars without a new frame. An additional 30 points may be deducted if the photographic documentation shows that the remaining parts of the vehicle have not been significantly changed (e.g. the intake manifold is obviously the same or it is obvious that the old suspension was simply bolted to a new frame, or none of the team members show an understanding of the design of various components). If the new frame is similar to last years, it is advisable to bring along evidence of the change (bringing along the old frame is not a bad idea).

4.6.12 Photographic Requirements

All teams should provide photos of their vehicle upon entering the design tent. These photos should show the basic design of the major components. A total of four photos are recommended. These photos are to aid the judges in selecting semi-finalists and are not the photos which will be used for yearly documentation. Teams not providing these photos will not progress to the design semi-finals. Polaroids are acceptable.

4.7 Acceleration Event

4.7.1 Acceleration Event Objective

The acceleration event evaluates the car's acceleration in a straight line on flat pavement.

4.7.2 Procedure

The cars will accelerate from a standing start over a distance of 75 m (82 yards) on a flat surface. The foremost part of the car will be staged at 0.30 m (11.8 inches) behind the starting line. A green flag will be used to indicate the approval to begin, however, time starts only after the vehicle crosses the start line. There will be no particular order of the cars in each heat. A driver has the option to take a second run immediately after the first.

4.7.3 Heats

There will be two heats. Each heat must have a different driver and each driver can have two runs. Starting order will be based upon time of arrival to the staging area. Heat 1 and 2 will not be run sequentially, but simultaneously. Heat 1 drivers will have starting priority over heat 2 drivers.

4.7.4 Tire Traction - Limitations

Special agents that increase traction may not be added to the tires or track surface and "burnouts" are not allowed.

4.7.5 Score

The acceleration score is based upon the corrected elapsed time. Elapsed time will be measured from the time the car crosses the starting line until it crosses the finish line. A two (2) second penalty will be added for each DOO (including entry and exit gate cones). An Off Course (OC) will result in a DNF for that run. Cars that have not run by the end of the event (determined by the organizer) will receive a Did Not Finish (DNF).

4.7.6 Scoring Formula

The score for the acceleration event is spread between zero (0) and seventy-five (75) based upon the elapsed time. The following equation is used to determine the scores for the event:

$$\text{ACCELERATION SCORE} = 75 * \frac{(5.8/T_{\text{your}}) - 1}{(5.8/T_{\text{min}}) - 1}$$

T_{min} will be the elapsed time of the fastest car.

The maximum acceptable acceleration time is 5.8 seconds corresponding to an average speed of 46.55 km/hr.

DNF = zero (0) points.

Negative points will not be given.

4.8 Skid-Pad Event

4.8.1 Skid-Pad Event Objective

The concept of the skid-pad event is to measure the cornering ability of the car on a flat surface while making a constant-radius turn.

4.8.2 Heats

Each car may compete in two heats. Each heat must have a different driver, and each driver may have two (2) runs.

There may exist two separate skid-pad locations. Heat one (1) will be run on skid-pad one (1) and Heat two (2) will be run on skid-pad two (2). Heat one (1) drivers must complete both of their runs on skid-pad one (1), and heat two (2) drivers must complete both their runs on skid-pad (2).

If there is only one skid-pad location, then both heat one (1) and heat two (2) will be run on the same skid-pad at the same time.

4.8.3 Heat Priority

There will be no distinction between heat one (1) and heat two (2) and there will be no particular starting order. Heat one (1) drivers will have a starting priority over heat two (2) drivers. Cars which have not run by the event closing (determined by the organizer) will receive a DNF for the event.

4.8.4 Skid-Pad Layout

There will be two circles of 15.25 m (50.03 feet) diameter in a figure eight pattern. The circle centers will be separated by 18.25 m (59.88 feet), and a driving path 3.0 m (9.84 feet) in width will be marked with pylons and a chalk line just outside the pylons. The start/stop line is defined by the centers of the two (2) circles. A lap is defined as traveling around one (1) of the circles from the start/stop line and returning to the start/stop line.

4.8.5 Skid-Pad Layout - Pylons

Sixteen (16) pylons will be placed around the inside of each circle and sixteen (16) around the outside of each circle. Additional pylons will establish the required entry and exit gates. Also, a cone will be placed in the middle of the exit gate to prevent drivethroughs until the finish lap.

4.8.6 Procedure

The cars will enter perpendicular to the figure eight and will take one full lap on the right circle to establish the turn. The next lap will be on the right circle and will be timed. Immediately following the second lap, the car will enter the left circle for the third lap. The fourth lap will be on the left circle and will be timed. Immediately upon finishing the fourth lap, the car will exit the track. The car will exit at the intersection moving in the same direction as entered. A driver has the option to take a second run immediately after the first.

4.8.7 Penalties

The elapsed time for the right and left circle will be averaged together after the following penalties have been assessed.

4.8.7.1 Cones Down Or Out (DOO)

A penalty of 0.25 seconds will be added to the time for every cone that is knocked "down or out" (including gate cones).

4.8.7.2 Off Course

Cars that spin-out can continue as long as they have not gone off course. Cars going off course are classified DNF.

4.8.7.3 Incorrect Number of Laps

Cars that run an incorrect number of laps are classified as DNF.

4.8.8 Skid-Pad Scoring

The skid-pad score is computed based upon the lateral acceleration capability. Lateral acceleration (typically referred to as G's) is computed from $2.012 \text{ diameter}/t^2$. A diameter of 17.10 m will be assumed in computing lateral G's. If there are two separate skid-pad locations, then the score will be based on the best run from either skid-pad. The following equation is used to determine the scores for the skid-pad event:

$$\text{SKID-PAD SCORE} = 50 * \frac{(6.184/T_{\text{your}})^2 - 1}{(6.184/T_{\text{min}})^2 - 1}$$

Where T_{your} will be the average of the left and the right timed laps on your best run including penalties. T_{min} will be the elapsed time of the fastest car. Negative points will not be given. The minimum acceptable lateral acceleration is 0.90 G's corresponding to 6.184 seconds per circle.

4.9 Autocross Event

4.9.1 Autocross Concept

The concept of the autocross event is to evaluate the car's maneuverability and handling qualities on a tight course without the hindrance of competing cars. The autocross course will combine the performance features of acceleration, braking, and cornering into one event.

4.9.2 Procedure



There will be two Autocross-style heats, with each heat having a different driver. The car will be staged such that the front wheels are 2 m behind the starting line. The timer starts only after the car crosses the start line. There will be no particular order of the cars to run each heat but a driver has the option to take a second run immediately after the first. Two (2) timed laps will be run (weather and time permitting) by each driver and the best lap time will stand as the time for that heat. The organizer will determine the allowable windows for each heat and retains the right to adjust for weather or technical delays. Cars that have not run by the end of the heat will be disqualified for that heat.

4.9.3 Course Specifications & Speeds

The following specifications will suggest the maximum speeds that will be encountered on the course. Average speeds should be 40 km/hr (25 mph) to 48 km/hr (30 mph).

Straights:	No longer than 60 m (200 feet) with hairpins at both ends (or) no longer than 45 m (150 feet) with wide turns on the ends.
Constant Turns:	23 m (75 feet) to 45 m (148 feet) diameter.
Hairpin Turns:	Minimum of 7 m (23 feet) OD.
Slaloms:	Cones in a straight line with 7.62 m (25 feet) to 12.19 m (40 feet) spacing.
Miscellaneous:	Chicanes, multiple turns, decreasing radius turns, etc. The minimum track width will be 3.5 m (11.5 feet).

The length of each run will be approximately 0.805 km (1/2 mile) and the driver will complete a specified number of runs. The time required to complete each run will be recorded and the time of the best run will be used to determine the score.

4.9.4 Penalties

The cars are judged on elapsed time plus penalties. The following penalties will be added to the elapsed time:

- 4.9.4.1 Cone Down or Out (DOO)
Two (2) seconds per cone.

- 4.9.4.2 Off Course
Driver must re-enter the track at or prior to the missed gate or a twenty (20) second penalty will be assessed.

Penalties will not be assessed for accident avoidance or other reasons deemed sufficient by the track official.

4.9.5 Stalled & Disabled Vehicles

If a car stalls and cannot restart itself without external assistance, the car will be deemed disabled. Cars deemed disabled will be

*WHAT IS THE PENALTY FOR
A MISSED SLALOM CONE?*



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cleared from the track by the track workers. At that time, two (2) team members may retrieve the car to the paddock. The track workers will signal for more team members as required.

4.9.6 Corrected Elapsed Time

Elapsed time plus penalties will be used as the corrected elapsed time. Cars that are unable to complete the course with an average speed of 80% of the fastest car will not be awarded points. This means that any autocross time in excess of 125% of the fastest time will receive no points. Negative points will not be given.

4.9.7 Scoring Formula

The following equation is used to determine the autocross score:

$$\text{AUTOCROSS SCORE} = \frac{(T_{\max}/T_{\text{your}}) - 1}{(T_{\max}/T_{\min}) - 1} * 150$$

Where T_{\max} will be equal to 125% of T_{\min} . T_{\min} will be the lowest corrected elapsed time recorded for any competitor in either heat. T_{your} will be the lowest corrected elapsed time of either heat for the team being scored.

4.10 Endurance and Fuel Economy Event

NOTICE: The endurance and fuel economy event will consist of a single heat.

4.10.1 Right to Change Procedure

The following are general guidelines for conducting the endurance and fuel economy event. The organizer reserves the right to establish procedures specific to the conduct of the event at the site. All such procedures will be made known to the teams through newsletters or the SAE website.

4.10.2 Endurance Objective

The Endurance Event is designed to evaluate the overall performance of the car and to test the car's reliability.

4.10.3 Fuel Economy

The car's fuel economy will be measured in conjunction with the endurance event. The fuel economy under racing conditions is

important in most forms of racing and also shows how well the car has been tuned for the competition. This is a compromise event because the fuel economy score and endurance score will be calculated from the same heat. No refueling will be allowed during an endurance heat.

4.10.4 Course Specifications & Speeds

Course speeds can be estimated by the following course specifications. Average speed should be 48 km/hr (29.8 mph) to 57 km/hr (35.4 mph) with top speeds of approximately 105 km/hr (65.2 mph).

Straights:	No longer than 77.0 m (252.6 feet) with hairpins at both ends (or) no longer than 61.0 m (200.1 feet) with wide turns on the ends. There will be passing zones at several locations.
Constant Turns:	30.0 m (98.4 feet) to 54.0 m (177.2 feet) diameter.
Hairpin Turns:	Minimum of 9.0 m (29.5 feet) OD.
Slaloms:	Cones in a straight line with 9.0 m (29.5 feet) to 15.0 m (49.2 feet) spacing.
Miscellaneous:	Chicanes, multiple turns, decreasing radius turns, etc. The minimum track width will be 4.5 m (14.76 feet).

4.10.5 General Procedure

The event will be run as a single 22 km (13.66 mile) heat. Teams will not be allowed to work on their vehicles during the heat. A driver change must be made during a three minute period at the mid point of the heat.

4.10.6 Fuel Fill

Before entering the event each vehicle's fuel tank must be filled to the fuel level line (see section 3.5.3.3, "Fuel Level Line") at the fueling station.

During fueling, once filled to the scribe line, no shaking or tilting of the tank or fuel system (incl. entire vehicle) is allowed.



4.10.7 Vehicle Starting/ Restarting

The vehicle must be capable of starting / restarting without external assistance at all times once the vehicle has begun the heat. If the vehicle cannot be started / restarted without external assistance, the car will be deemed disabled and will be disqualified from the heat.

4.10.8 Driver Change Procedure

Elapsed time will begin when Driver A enters the course and crosses the timing line. Driver A will drive for 11 km, and pull into the driver change area. Three (3) minutes are allowed for the team to change drivers.

Driver A will exit the vehicle and any necessary adjustments will be made to the vehicle to fit Driver B (seat cushions, pedal position, etc.). Other than the two drivers, only one team member will be allowed in the driver change area, and only the tools necessary to change drivers will be carried into this area (no tool chests etc.). Extra people entering the driver change area will result in a 20 pt penalty to the final endurance score for each extra person entering the area.

Driver B will then be secured in the vehicle. The driver change area will be placed such that the timing system will see the driver change as an extra long lap. Unless this driver change takes longer than three minutes, this extra long lap will not count. If the driver change takes longer than three minutes, the extra time will be counted into the final time.

Driver B will drive for 11 km, and elapsed time will stop when the car completes the total 22 km distance.

Driver B will proceed directly to the fueling station. The tank will be filled to refill mark and the amount will be recorded.

4.10.9 Entering the Track

Cars will be allowed to enter the track based upon the level of traffic on the course. From 5 to 7 vehicles will be allowed on the track at once. This includes any vehicles in the driver change area.

Since repairs will not be allowed during the heat, and there will be no refueling during the heat, there will not be a restart queue of any kind.

4.10.10 Run Order

The run order for the heat will be based off the results of the autocross event, with the fastest team first followed by the second fastest, etc. Teams will be expected to keep track of the run order and have their vehicle fueled and ready in time for their turn to run. If a team is not ready to start when their turn arrives (i.e. at the starting line, full of fuel and ready to start the vehicle), they will be penalized two minutes and be allowed to run at the end of the heat (time permitting). It is recommended that teams show up at the refueling station at least a half hour before the event, as it will be the team's responsibility to be refueled on time to run.

4.10.11 Breakdowns & Stalls



If a vehicle breaks down it will be removed from the course and will not be allowed to re-enter the course (if a vehicle stalls, or ingests a cone, etc., it will be allowed to restart and re-enter the course where it went off, but no work may be performed on the vehicle).

If the car stalls and cannot be restarted without external assistance, the track workers will push the car clear of the track. At that time, two (2) team members may retrieve the car under direction of the track workers.

4.10.12 Minimum Speed Requirement

If a car is unable to maintain lap times within 133% of the fastest lap time for the course, then it must exit immediately.

4.10.13 Exiting the Course

Vehicles must power down after leaving the course and be pushed into and out of the fueling area.

Fuel pumps will be turned on and fuel valves will be opened to insure complete refueling.

4.10.14 Lap Timing

Each lap of the endurance event will be individually timed either by electronic means, or by hand. The time for an individual heat will be determined by subtracting the extra long lap for the driver change from the total time and adding any penalty points.

4.10.15 Penalties

Penalties will not be assessed for accident avoidance or other reason deemed sufficient by the track official.

Further driving rules and the meaning of flags are discussed in the Driving Rules section.

The following penalties will be assessed:

4.10.15.1 Aggressive Driving

Any aggressive driving behavior (such as forcing another car off the track, refusal to allow passing, or close driving that would cause the likelihood of car contact) will result in a black flag for that driver. When a driver receives a black flag signal, he must proceed to the penalty box to listen to a reprimand for his driving behavior. The amount of time spent in the penalty box will vary from zero to four minutes depending upon the severity of the offense.

4.10.15.2 Inexperienced Driver

The Chief Course Judge may disqualify a driver in the interest of safety if the driver is inexperienced or too aggressive, resulting in a DNF.

4.10.15.3 Cones

Cone down or out (DOO) - two (2) seconds per cone

4.10.15.4 Mechanical Problem

Assessed Time - time needed for car inspection by an SCCA technical inspector.

4.10.15.5 Off Course (OC)

For an OC, the driver must reenter the track at or prior to the missed gate or a twenty (20) second penalty will be assessed.

4.10.15.6 Out of Order

Out of order running - two (2) minutes.



4.10.15.7 Poor Fuel Economy

Mileage exceeding 26 liters/100 km -four (4) minutes.

4.10.15.8 Penalties for Moving Violations

The following are penalties and assessed times or disqualifications for moving violations:

- (a) Failure to yield at flag 1 minute
- (b) Over Driving (After a closed black flag) 1 Minute
- (c) Vehicle to Vehicle contact DISQUALIFIED

4.10.16 Scoring



The score for the Endurance Track Event is the sum of the Endurance Time Score and the Endurance Finish Score. The Endurance Time Score is based on the team's time for the event, including penalties, compared to the fastest team. A car will also receive an Endurance Finish Score of fifty (50) points if the team's time for the event, including penalties, is less than or equal to the maximum allotted time. The total Endurance Score is calculated using the formula below.

4.10.17 Endurance Scoring Formula



The times for the endurance event will be based upon the sum of the times of each driver in the heat plus penalties.

The following equation is used to determine the time scores for the event:

If T_{your} is $<$ or $=$ to T_{max} :

$$ENDURANCE\ SCORE = 300 * \frac{(T_{max}/T_{your}) - 1}{(T_{max}/T_{min}) - 1} + 50$$

If $T_{your} > T_{max}$: ENDURANCE SCORE = 0 (ZERO)

T_{min} will be the lowest corrected time of the fastest team of the event.

T_{your} will be the combined corrected times of the drivers in your heat.

T_{max} will be based upon an average speed of 75% of the fastest team of the event; therefore, T_{max} will be 1.333 times T_{min} .

4.10.18 Fuel Economy

The fuel economy score is based on the average liter per kilometer fuel economy obtained during the endurance heat.

4.10.19 M85 Correction Factor

The volume of M85 fuel will be divided by a 1.75 correction factor to determine the gasoline equivalent volume. This correction factor is equal to the ratio of energy (lower heating value) per unit volume of gasoline to M85.

4.10.20 Fuel Economy Scoring Formula

The following equation will be used to determine the fuel economy score:

$$\text{FUEL ECONOMY SCORE} = \frac{(V_{\max} N_{\text{your}}) - 1}{(V_{\max} N_{\text{minr}}) - 1} * 50$$

Where V_{\max} will equal 5.72 liters (1.51 gallons) and will be adjusted to represent 26 liters/100km (9.04 mpg) if the course is shortened. V_{\min} will be the smallest volume of fuel used by any competitor. Vehicles which consume more than 5.72 liters of fuel during the course of the endurance heat or whose corrected time exceeds 1.333 times the corrected time of the fastest team, will receive 0 pts. for fuel economy.

For shortened courses, V_{\min} will be the low value per heat.

Fuel economy scores can range from zero (0) to fifty (50) points.

4.10.21 Post Event Engine Check

The organizer reserves the right to impound any vehicle immediately after the event to check engine displacement (method to be determined by the organizer) and restrictor size.

4.11 Flags

The flag signals convey the commands described below, and shall be obeyed immediately and without question.

4.11.1 Flagging for Formula SAE

There are two kinds of flags for the competition: Command flags and

Informational flags. Command flags are just that, flags that send a message to the competitor that the competitor must obey without question. Informational flags, on the other hand, require no action from the driver, but should be used as added information to help him or her to maximize performance. What follows is a brief description of what each flag means for this competition.

COMMAND FLAGS

YELLOW FLAG (Stationary)	Danger, SLOW DOWN, be prepared to take evasive action, something has happened beyond the flag station. NO PASSING unless directed by the corner workers.
(Waved)	Great Danger, SLOW DOWN, evasive action is most likely required, BE PREPARED TO STOP, something has happened beyond the flag station, NO PASSING unless directed by the corner workers.
BLUE FLAG (Blue w/Yellow daigonal stripe)	Pull into the designated passing zone to be passed by a faster competitor. Obey the corner workers hand signals at the end of the passing zone to safely merge into competition.
RED FLAG	Come to an immediate safe controlled stop on the course. Pull to the side of the course as much as possible to keep the course open. Follow corner worker directions.
BLACK FLAG	Pull into the penalty box for discussion with the Director of Operations or other official concerning an incident of course. A time penalty may be assessed for such incident.
BLACK FLAG WITH ORANGE DOT GREEN FLAG	Pull into the penalty box for a mechanical inspection of your car, something has been observed that needs closer inspection. Your session has started, enter the course under direction of the starter. (NOTE: If you stall the vehicle, please restart and await another green flag as the opening in traffic may have closed.)
CHECKER FLAG	Your session has been completed. Exit the course at the first opportunity.

INFORMATIONAL FLAGS

RED AND YELLOW STRIPED FLAG	Something is on the racing surface that should not be there. Be prepared for evasive maneuvers to avoid the situation. (Corner workers may be able to point out what and where it is located, but do not expect it.)
WHITE FLAG	There is a slow moving vehicle on the course that is much slower than you are. Be prepared to approach it at a cautious rate.

4.12 Rules of Conduct

4.12.1 Competition Objective

The Formula SAE® event is a design engineering competition that requires performance demonstration of vehicles and is NOT a race. Engineering ethics will apply. It is recognized that hundreds of hours of labor have gone into fielding an entry into Formula SAE®. It is also recognized that this event is an "engineering educational experience" but that it often times becomes confused with a high stakes race. In the heat of competition, emotions peak and disputes arise. Our officials are trained volunteers and maximum human effort will be made to settle problems in an equitable, professional manner.

4.12.2 Violations of Intent

In all events, violation of the intent of the rule will be considered a violation of the rule.

4.12.3 Loopholes & Problems

Any perceived loopholes or potential problems should be identified in writing to the organizer. The organizer will then clarify the matter and advise all participants.

4.12.4 Unsportsmanlike Conduct

In the event of unsportsmanlike conduct, the team will receive a warning from an official. A second violation will result in expulsion of the team from the competition.

*No powered vehicles on pits or track
" skateboards
" roller blades
New speeds in bicycles,*

4.12.5 Arguments with Officials

ARGUMENT WITH, OR DISOBEDIENCE TO, ANY OFFICIAL MAY RESULT IN THE TEAM BEING ELIMINATED FROM THE COMPETITION. ALL MEMBERS OF THE TEAM MAY BE IMMEDIATELY ESCORTED FROM THE GROUNDS.

4.12.6 Alcohol and Illegal Material

NO ALCOHOL, ILLEGAL MATERIAL, FIREARMS OR WEAPONS OF ANY TYPE ARE PERMITTED ON THE COMPETITION SITE. THIS RULE WILL BE IN EFFECT DURING THE ENTIRE COMPETITION. ANY VIOLATIONS OF THIS RULE WILL CAUSE THE IMMEDIATE EXPULSION OF ALL MEMBERS OF THE TEAM, NOT JUST THE INDIVIDUAL MEMBER FOUND IN VIOLATION. THIS RULE APPLIES TO ALL TEAM MEMBERS AND FACULTY ADVISORS. ANY USE OF DRUGS OR USE OF ALCOHOL BY AN UNDERAGE INDIVIDUAL WILL BE REPORTED TO THE LOCAL AUTHORITIES FOR PROSECUTION.

4.12.7 Parties

Disruptive parties either on or off-site should be prevented by the Faculty Advisor.

4.12.8 Trash Clean-up

Cleanup of trash and debris is the responsibility of the teams. The team's work area should be some defined area that should be kept uncluttered. At the end of the day, each team will clean all debris from their area and help with maintaining a clean paddock. Teams are required to remove all of their material and trash when leaving the site at the end of the competition

Teams that abandon furniture, or that leave a paddock that requires special cleaning, will be billed for removal and/or cleanup costs.

4.13 General Rules

4.13.1 Dynamometer Usage

If a dynamometer is available, it may be used by any competing team during the specified time. All vehicles to be dynamometer tested must have acquired the safety & technical inspection decal prior to testing. Fuel, ignition and drivetrain tuning will be permitted while testing on the dynamometer.

4.13.2 Problem Resolution

Any problems that arise during the competition will be resolved through the Operations Center and the decision will be final.

4.13.3 Protests

a) Cause for Protest - If a faculty advisor or team captain feels a complaint about an official action or rules interpretation was not properly addressed by event officials, he/she may protest. Protests should be filed by the team steward.

b) Protest Period - Protests must be filed within one (1) hour after the scores for the activity involving the protest subject are posted.

c) Protest Format - All protests must be in writing and submitted to designated organizer. Protest forms may be obtained from the organizer.

d) Protest Bond - The protesting team must post a twenty (20) point bond to be deducted from their score if the protest is denied.

e) Decision - The decision of the judges or organizers regarding any protest is final.

4.13.4 Forfeit for Non-Appearance

It is the responsibility of teams to be in the right place at the right time. If a car is not ready to compete at the scheduled time, then the team forfeits the run of the event and will not be offered a late make-up.

4.13.5 Drivers Meetings

All drivers for an event are required to attend the pre-event drivers meeting. The driver for an event will be disqualified if he does not attend the driver meeting for the event.

4.13.6 Personal Vehicles

Personal cars and trailers must be parked in designated areas only. Only FSAE competition vehicles will be allowed in the track areas.

4.13.7 Organizer Authority

The organizer(s) of the competition reserve the sole right to revise the schedule of the competition and/or to interpret the competition rules at any time and in any manner which is in their sole judgement, required for efficient operation or safety of the competition.

4.13.8 Understanding the Rules

Teams are responsible for reading and understanding the rules in effect for each competition. The section and paragraph headings in these rules are provided only to facilitate reading, they do not affect paragraph contents.

4.14 Pit Rules

4.14.1 Moving Vehicles

Vehicles may not move under their own power anywhere but the practice or competition tracks. Off track vehicles must be pushed at a normal walking pace and with a team member walking beside the car. Cars with wings are required to have two team members walking on either side of the vehicle whenever the vehicle is in motion. During the performance events when the excitement is high, it is particularly important that the car be moved at a very slow pace in the pits; the walking rule will be enforced and point penalties will be assessed for violations of this rule.

4.14.2 Smoking - Prohibited

Smoking is prohibited in all competition areas.

4.14.3 Refueling

All refueling must be conducted by race officials.

4.15 Driving Rules

4.15.1 Off Course Speed Limit

Cars must be pushed at a normal walking pace when going from one area to another with a team member walking beside the car.

4.15.2 Driver Equipment

The driver safety equipment specified in 3.4.2 must be worn whenever the vehicle is moving under its own power or is running on a chassis dynamometer.

4.15.3 Practice Track

At the organizers discretion, a practice area may be provided to test and tune the cars. The practice area will be supervised and the number of cars in the area controlled. The cars may not be driven under power anywhere except in the practice area and during the

actual events. Practice at any location other than the authorized practice track is absolutely prohibited. Competition cars are prohibited from driving at any time (day or night) other than in official competition or the practice areas. Unauthorized testing will result in a point penalty from the competition officials. Officials will give only one warning to any team.

4.15.4 Endurance Event Safety

The safety of this competition and especially the endurance track event will be considered as the ultimate responsibility of the competitors. Thus, aggressive driving, running cars off the track, not yielding to passing signals, etc. will result in a black flag and a discussion of the driving behavior with competition officials in the penalty box. The time spent in the penalty box will be included in run time and serve as a reprimand as well as to inform the driver exactly what he/she did wrong. Drivers should be especially aware that open-wheeled cars are inherently dangerous due to the possibility of two tires touching and throwing one car into the air. The endurance event is a timed event; each driver is competing with the clock and is not racing other cars; therefore, aggressive driving is not necessary.

4.15.5 Endurance Event - Passing

Passing during the Endurance Event is of primary concern. Two or more passing zones will be established on the track. Passing is allowed only in the passing zones and will be controlled by the track officials. These passing rules do not apply to a competing car passing cars that are disabled on the track or have spun-out and are not moving. The passing zones will be located at the exit of a turn onto a straight-away. There will be two parallel lanes separated by pylons. Upon entrance to the turn, the slower car will be blue flagged and will move to the inside of the turn and enter the inside passing lane; the faster car will move to the outside of the turn and will enter the outside lane. The faster car will make the pass in the outside lane and a flagman at the exit of the inside passing lane will signal the slower car when it can re-enter the track (after the faster car has completed the pass). All cars will use the outside lane under normal conditions.

REMINDER:

ALL DRIVERS OF AN EVENT MUST ATTEND THE DRIVER'S MEETING FOR THE EVENT OR BE DISQUALIFIED FOR THAT EVENT. THE FACULTY ADVISOR WILL VERIFY ATTENDANCE.

4.16 Definitions

DOO	A cone is "Down or Out" if it has been: (a) - Knocked over or (b) - The entire base of the cone lies outside the box marked around the cone in its undisturbed position.
DNF	Did Not Finish.
Entry Gate	The path marked by cones which establishes the required path the vehicle must take to enter the course.
Exit Gate	The path marked by cones which establishes the required path the vehicle must take to exit the course.
Gate	The path between two cones through which the car must pass. Two cones, one on each side of the course define a gate: Two sequential cones in a slalom define a gate.
Staging Area	An area prior to the entry to an event for the purpose of gathering those cars which are about to start.
OC	A car is Off Course if it does not pass through a gate in the required direction.

5. NOTICE OF PROPOSED RULE CHANGES EFFECTIVE WITH FORMULA SAE 2002

This section is intended to provide teams with advanced notice of changes to the Formula SAE rules which the rules committee has proposed and discussed. These proposed rules will become effective for the 2002 competition. This section covers only rules which may have significant influence on team's engineering design and manufacturing decisions. The following are sections effected by 2002 rules changes:

Fuel - Beginning with the 2002 Formula SAE competition, M85 will be replaced with E85.

Sections 3.5.2 Fuel Allowed, 3.5.2.2 Fuel Additives Prohibited, 3.5.3 Fuel System, 3.5.3.1 Fuel Tank Size Limit, 3.5.4.2 Intake System Restrictor, 4.10.19 M85 Correction Factor, other sections referencing M85 or fuel may also be subject to change.

Noise - The maximum allowable sound level will be reduced from 110dBA fast weighting to 107 dBA fast weighting.

Sections 3.5.5.3 Noise and other sections referencing Sound or Noise levels may also be subject to change.

6. QUESTIONS ABOUT RULES

Questions about the rules of Formula SAE, including requests for interpretation, must be submitted in writing to the FSAE Consultant by e-mail to:

Kathleen McDonald, Creative Consulting Services
e-mail: katklauz@aol.com

All questions and responses concerning the rules and the competition will be made available to all participants.

FSAE™ EVENT SAFETY STRUCTURE EQUIVALENCY FORM

This form must be completed and sent to the host **no later than March 1, 2001** and then will be submitted to the FSAE™ Technical Committee for approval of designs which deviate from the Formula SAE® construction rules for Roll-over Protection or Side Impact Protection. This form must also accompany the vehicle to Safety and Technical Inspection.

University Name _____

Team Contact _____

Telephone Number _____

Department _____

Room and Building _____

Address _____

City, State, Zip _____

E-mail: _____

Faculty Advisor _____

Telephone Number _____

E-mail: _____

Rule Deviated (include number) _____

Description of Deviation (include drawing if necessary) _____

Attach Proof of Equivalency

Roll bar documentation should include material type(s), material certification(s), properties, heat treatment, and strength calculations showing equivalency. Side impact documentation should include material type(s), material certification(s), properties, heat treatment, cloth weights, resin type, fiber orientation, number of layers, core material, lay-up technique, and strength calculations showing equivalency.

TECHNICAL COMMITTEE DECISION/COMMENTS

**Send this form to: Kathleen McDonald, Creative Consulting Services, 1280 East Buell, Oakland Twp., MI 48306
Fax: (248) 601-8934**

SCHOOL:		CAR NUMBER:	
TALLEST DRIVER:		HEIGHT:	
		NUMBER OF DRIVERS	
IMPORTANT			
PRESENT THE VEHICLE FOR INSPECTION IN THE FOLLOWING ORDER:			
1. SAFETY & TECHNICAL INSPECTION			
2. FUEL CAPACITY & TILT TABLE INSPECTION			
3. NOISE LEVEL & BRAKING PERFORMANCE INSPECTION			
THIS FORM MUST STAY WITH THE CAR UNTIL ALL PARTS OF INSPECTION HAVE BEEN COMPLETED			
PART 1			
SAFETY & TECHNICAL INSPECTION			
SAFETY EQUIPMENT			
HELMETS - Snell M90, SA90, M95, SA95, BS 6658-85 Type A or A/FR rating.		GOGGLES / SHIELDS - made of impact resistant material.	
DRIVER'S SUITS - FIA 1986 Standard or SFI 3.2A/1 minimum rating, and labeled as such.		GLOVES / SHOES - Fire resistant material. No holes. No leather gloves.	
HAIR COVER- No hair to protrude from beneath helmet. Long hair requires Nomex balaclava.		ARM RESTRAINTS - Must be installed such that the driver can release them and exit unassisted regardless of vehicle's position.	
SAFETY HARNESS - 5 or 6 point with single metal quick release; must meet SFI/16.1 spec and be labeled; 76 mm (3in.) lap belt must pass over pelvic area; 50 mm (2 in.) shoulder belts must attach behind the driver above an angle of 40 deg. to the horizontal; 50 mm (2 in.) anti-submarine strap(s); all attached securely to primary structure-1.00"ODx0.065" tube min.		FIRE EXTINGUISHER - On-board hand-held extinguisher NOT ALLOWED. On-board fire system encouraged. Team to have two (2) hand-held, 0.9 kg (2 lb.), dry chemical 10BC or 1A10BC, Halon 1301 or 1211, AFFF, or CEA-614 extinguishers, 1 WITH CAR, 1 in paddock. (Need to see BOTH at Tech.).	
MASTER SWITCHES - Two switches, one located on driver's right near roll bar, accessible from outside of car; the other located accessible by driver. Both must kill all electrical systems, and be marked with international symbol.		BRAKE PEDAL O/TRAVEL SWITCH - Must cut ignition & fuel pump; no re-start if released or actuated a second time.	
DRIVER PROTECTION			
ROLL-OVER PROTECTION - <u>New chassis</u> - Main & front hoops to be 25.4 mm (1.0") OD x 2.36 mm (0.095") wall steel. Bracing to be 25.4mm (1.0") OD x 1.65mm (0.065") min. Same dims. for alloy steel. Other materials or dims. need SSE Form with min. wall of 0.083" for steel, & 0.125" for aluminum. "Old" chassis-if complies with 2000 rules, must be entered as "2nd Year Car". 0.18" inspection holes req'd in non-critical areas of front & main hoops for all.		SIDE IMPACT PROTECTION - A frame member, positioned between 200 mm and 350 mm (7.87" and 13.78") above the ground, must connect the main and front hoops. At least one diagonal per side must connect the upper and lower frame members between the main and front hoops. All tubes to be 25.4 mm (1.0") OD x 1.65 mm (0.065") wall steel or equivalent. Monocoques require approval documents.	
MAIN HOOP - Must be within 10 deg. of vertical. Helmet of tallest driver or 95th percentile male to be 50 mm (2.0 in.) below line between top of front and main (rear) roll hoops; if a point forward of the front hoop is used, approval documents are required. Hoop must be 1 piece & extend to bottom of lowest frame member. (See note above for "2nd Year Cars".)		FRONT IMPACT PROTECTION - Feet must be contained within major structure & rearward of a bulkhead of 1.0" x 0.065" steel tube or equiv. No solid objects forward of bulkhead. Need 150 mm (5.9") of crush zone from bulkhead forward to plane where section is 10 cm (3.9") high x 20 cm (7.9") wide. Crush material must be securely fastened directly to the bulkhead. No tape, etc.	
MAIN HOOP BRACING - One brace each side, attached within 16 cm (6.3 in.) of top, min. 30 deg. included angle with hoop. If main hoop is not vertical, bracing must not be on same side of vertical as main hoop.		ROLL BAR PADDING - Rollbar/bracing that could be contacted by driver's helmet must be covered with 12.7 mm (0.5 in) thick padding.	
FRONT HOOP - No lower than top of steering wheel with wheel in any orientation; two forward facing braces attached within 5 cm. (2 ins) of top.		HEAD RESTRAINT - 38.1 mm (1.5 in) thick, 232 sq.cm. (36 sq.ins), padded, no more than 25.4 mm (1.0") from helmet. Must take 890 N (200 lbs.f) load.	
STEERING, SUSPENSION, BRAKES			
GROUND CLEARANCE - Sufficient to prevent any portion of the car from touching the ground during track events.		FASTENERS - Steering, braking, harness and suspension systems must use SAE Grade 5 or Metric Grade M8.8 or higher specs (AN/MS); rod ends in single shear must be captured by a washer larger than the ball diameter. Adjustable tie-rod ends must have jam nuts to prevent loosening.	
SUSPENSION - Fully operational with dampers front and rear; 50mm (2.0 in) minimum wheel travel with driver in vehicle.		BRAKES - Dual hydraulic system & reservoirs, operating on all four wheels, (one brake on limited slip is OK). System must be protected by structure or shields from d/train failure and minor collisions. No plastic brake lines.	
STEERING - On at least two wheels with positive stops to prevent linkage lock up or tires from contacting any part of the car. 7 degrees max. freeplay at the steering wheel.		BRAKE LIGHT - Car must have a working brake light of at least 15 watts or equiv., clearly visible from the rear; height & lateral location requirements.	
WHEELS - Four wheels not in a line, 20.32 cm (8.0 in) minimum diameter.			
ENGINE COMPARTMENT			
ENGINE - Four cycle piston engine 610 cc maximum swept displacement. Fuel rails to be attached with mechanical fasteners.		EXHAUST OUTLET - Outlet no more than 60 cm (23.6") behind rear axle centerline or more than 60 cm (23.6") above the ground.	
RESTRICTOR - Diameter of restrictor must be no larger than 20 mm (0.787 in) for gasoline fueled cars and 18 mm (.7087 in) for M85 fueled cars.		COMPRESSORS - Turbo or super chargers allowed if not OEM to engine; must be between restrictor and engine.	
THROTTLE CABLE - Must be at least 50.8 mm (2 in) from any exhaust component and out of exhaust stream; must have smooth operation with no actuation must use at least two springs to close throttle independently; push-pull type recommended but optional.		SCATTERSHIELDS - 12 gauge 2.67 mm (0.105 in) mild steel protecting exposed high speed equipment such as clutches, drive belts and chains.	
THROTTLE PEDAL - Must have positive stop before overstressing cable.		JACKING POINT - Must have an exposed tube at the rear perpendicular to the longitudinal axis 30.46 cm (12.0 in) long by 2.54 cm (1.0 in) O.D.	
OIL LEAKS - None permitted.		CATCH TANKS - Must have separate tanks for oil breathers & coolant overflow. One quart minimum each.	
		COOLANT - Water or water with corrosion inhibitor only, no glycol or water pump lubricants added.	

PART 1, cont.		
SAFETY & TECHNICAL INSPECTION		
FUEL SYSTEM		
FUEL SYSTEM ROLL OVER PROTECTION - All parts of the fuel storage and supply system, engine air and fuel control systems, (including throttle body or carburetor, but excluding air cleaner systems), must lie within a surface defined by the top of the roll bar and the outside top edge of the tires.		FUEL FILLER NECK - Min. 30 mm (1.2 in) diameter & min. 80 mm (3.2 in) vertical height above top of tank. Needs fuel resistant, transparent sight tube, visible to fueler, with a permanent, non-moveable fuel level line 13 mm to 25 mm (0.5 in. -1.0 in.) below top of sight tube. Sight tube may NOT run from bottom of tank. Must prevent refueling spillage contacting driver, exhaust or ignition components.
FUEL TANKS - Must lie within major structure of the chassis.		BELLYPANS - Must be vented to prevent accumulation of fuel
FUEL LINES - High pressure over 103.4 kPa (15 psi) systems must use metal braided hose with threaded or modern OEM type fittings. Must be securely attached and protected from possible rotating equipment or collision failure.		FUEL VENTS - Must exit outside of the bodywork, and have a check valve to prevent leakage if car inverted.
INTERIOR		
STEERING WHEEL - Near round with driver operable quick disconnect. MIRRORS - Must have functional rear view mirrors.		FLOOR CLOSEOUT PANEL - Required from foot area to firewall; multiple panels are OK if gaps are less than 3.18 cm (1/8 in)
VISIBILITY - Must be adequate from front, rear and sides; roll bar and bracing must allow free rotation of driver's head to 90 degrees either side		FIREWALL - Fire resistant material; must separate driver compartment from fuel supply, cooling & oil systems. Pass-throughs OK with grommets.
VEHICLE CONTROLS - All controls, including shifter, must be inside cockpit. No arms outside major structural members to actuate.		Multiple panels OK but gaps should be sealed. Must protect (line-of-sight up to mid-height of driver's helmet) from cooling, oil and fuel systems.
EXTERIOR, GENERAL		
WHEELBASE - Minimum 1524 mm (60 in)		BODY & STYLING - Open wheeled, open cockpit, formula style body.
CAR NUMBERS, DECALS & SCHOOL NAME - Clearly visible must be: Car Number - 15.24 cm (6") tall min. on front & both sides of car (B on W, W on B or equiv.); School Name, or recognised initials - 5.1cm (2") tall min. on both sides; Event and Fuel decals.		AERODYNAMICS - No power ground effects allowed. Wing leading edges must be 12.7 mm (0.5 in) minimum radius, or 19.05 mm (0.75 in) minimum radius if ahead of the front of the front tires. All other edges must be 3.175 mm (1/8 in.) minimum radius. Wings no wider than outside edge of tyres.
OTHER - Min. 38 mm (1.5 in.) radius on nose. No large openings in bodywork into driver compartment in front of or alongside driver, (except cockpit opening).		EGRESS - 5 seconds max. to exit to side of vehicle from fully seated position with all safety equipment; wings must remain fixed in position.
NON-COMPLIANCE / COMMENTS:		
APPROVED BY:		DATE:

SCHOOL:		CAR NUMBER:
TALLEST DRIVER:	HEIGHT:	NUMBER OF DRIVERS

IMPORTANT

THIS FORM MUST STAY WITH THE CAR UNTIL ALL PARTS OF INSPECTION HAVE BEEN COMPLETED

PRESENT THE VEHICLE FOR INSPECTION IN THE FOLLOWING ORDER:

- | | | |
|---|--|--|
| 1. SAFETY & TECHNICAL INSPECTION | | |
| 2. FUEL CAPACITY & TILT TABLE INSPECTION | | |
| 3. NOISE LEVEL & BRAKING PERFORMANCE INSPECTION | | |

PART 2

FUEL CAPACITY & TILT TABLE INSPECTION

FUEL TANK CAPACITY - 13.25 liter (3.5 U.S. gallon) max. for M85 fueled cars; 7.57 liter (2 U.S. gallon) max. for gasoline fueled cars	FUEL SPILLAGE - No fuel spill permitted when car is tilted to 45 degrees in the direction most likely to create spillage; Tanks must be filled to scribe line
FUEL STICKER - M85 fueled cars must have M85 sticker	ROLL OVER STABILITY - Car must not roll over when tilted 57 degrees in either direction with tallest driver on board

NON-COMPLIANCE / COMMENTS:

APPROVED BY: _____ DATE: _____

PART 3

NOISE LEVEL & BRAKING PERFORMANCE INSPECTION

NOISE LEVEL - 110 dB (A) ("A" scale) maximum during a static test, gearbox in neutral, engine at 3/4 maximum rpm. Microphone level with the exhaust outlet(s), 0.5 m (19.7") from the outlet(s), at 45 degrees to the outlet. If multiple outlets, all to be checked.	BRAKING PERFORMANCE - Must lock-up all four wheels on dry asphalt at any speed - evaluated after point of sound level measurement. If adjustments are made to the vehicle after three failed attempts before retest, the car may run on the Practice Track without the final Brake Performance tech Sticker.
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NOISE LEVEL: _____ ATTEMPTS: _____

NON-COMPLIANCE / COMMENTS:

APPROVED BY: _____ DATE: _____

2001 FSAE™ COST EVENT ADDENDUM

SCHOOL _____

CAR NUMBER _____

(Please indicate decreases using bracketed numbers.)

	Section	Original Reported Total	New Reported Total	Difference	Cost Judge Initials
1					
2					
3					
4					
5					
6					
7					
8					

Total Vehicle

\$ _____	\$ _____	\$ _____
----------	----------	----------

Explanation of Differences Listed Above:

1	
2	
3	
4	
5	
6	
7	
8	

Accepted by: _____ Entered by: _____

Date: _____ Date/Time: _____

Addendums will be accepted only at the time of registration!
These forms will then be forwarded to the cost judges the morning of the Cost event.

The 2001 FSAETM Cost Report must follow the organized list of systems and components outlined below. A detailed manufacturing process breakdown must be completed for each asterisked item. If these items were not manufactured by your team, a representative process must still be completed by your team (for purposes of discussion during the visual portion of the cost event). Any questions as to the correct location of the specific items should be submitted to the rules committee by 3/22/2001 and clarification will be made.

1) Brake System . . .

Brake Fluid	* Brake Master Cylinder	Area Total
Brake Lines	* Brake Discs	Graphics and/or photos
* Calipers	Fasteners	Receipts/Back-up
Brake Pads	Sub-totals of sub-components	

2) Engine and Drivetrain . . .

Engine	* Fuel Tank	Axles
Engine Mfr (Name)	Fuel Pump	Differential Mounts
Engine (cc)	Fuel Pressure Reg.	* Sprocket/Pulleys
Displacement	Fuel Filter	Differential Bearings
* Exhaust Manifold	Fuel Lines/Rails	* Differential
Muffler	Fuel Vent/Check Valve	CV Joints/U Joints
* Intake Manifold	Radiator	Shields
* Restrictor	Coolant	Engine/Diff Oil
Air Filter	Overflow Bottles	Fasteners
Turbo/Super Charger	Coolant Lines	Sub-Totals of Sub-Components
Carburetor / * Throttle Body	Radiator Fans	Area Total
Engine Mounts	Hose Clamps	Graphics And/Or Photographs
Oil Filter	Oil Cooler	Receipts/Back-Up
Spark Plugs	Chain / Belt	
Fuel Injectors	Ignition Coil / Wires	

3) Frame & Body . . .

* Pedals	Body Material	Shifter Cable/Linkage
Shifter	* Body Processing	Final Assembly
Throttle Controls	Body Attachments	Fasteners
* Frame / Frame Tubes	* Mounts Integral to Frame	Sub-Totals of Sub-Components
Welding	Floor Pan	Area Total
Tubes Cuts/Bends	Clutch	
Tube End Preps	Graphics And/Or Photographs	
* Aerodynamic Wing (if used)	Receipts/Back-Up	

4) Instruments, Wiring and Accessories . . .

Tachometer	Brake Light Bulb	Fasteners
* ECM/Engine Electronics	Solenoids	Sub-Totals of Sub-Components
* Wire Harness/Connectors	Indicator Lights	Area Total
Oil Pressure Gage/Light	Battery	Graphics And/Or Photographs
* Dash Panel	Relays	Receipts/Back-Up
Fuses	Starter Button	
Water Temperature Gage	Kill Switch	

5) Miscellaneous, Safety, Finish and Assembly . . .

* Seats	On-Board Fire Suppression Sys.	Sub-Totals of Sub-Components
Safety Harness	* Fire Wall	Area Total
Paint - Frame	Mirrors	Graphics And/Or Photographs
Paint - Body	Safety Shields	Receipts/Back-Up
Brake Light - Housing	* Headrest / Restraints	

6) Steering System . . .

* Steering Rack	* Steering Wheel Quick Release	Area Total
Tie Rods	Fasteners	Graphics And/Or Photographs
* Steering Shaft	Sub-Totals of Sub-Components	Receipts/Back-Up
Steering Wheel		

7) Suspension and Shocks . . .

Shocks	Rod Ends	Sub-Totals of Sub-Components
Springs	* Front Uprights	Area Total
* Suspension Mechanism	* Rear Uprights	Graphics And/Or Photographs
Pushrods/Pullrods	Fasteners	Receipts/Back-Up
* A/Arms or Equivalent		

8) Wheels, Wheel Bearings and Tires . . .

Wheels	Wheel Bearings	Sub-Totals of Sub-Components
* Lug Nuts	* Front Hubs	Area Total
Tires	* Rear Hubs	Graphics And/Or Photographs
Valve Stems	Wheel Studs	Receipts/Back-Up
Wheel Weights	Fasteners	

Report Evaluation (Overall Presentation)

Cover Letter	Organized Format	Bill of Material - req'd (electronic format /Excel Office 97) - (single 3.5" disk)
Introduction	Cover / Binder - including Car# and School Name	
Table of Contents	Plant Layout (optional)	Back-Up Data Complete
Cost Summary	Line Layout	Graphics and/or Pictures
Tabs	Content Accuracy	Assembly Labor Total in the

BOM

NOTE:

After each section or area, please include the corresponding pictures, sketches, diagrams, blueprints (if possible), back-up and receipts necessary for that area. The cost of fasteners and brackets are to be included in their respective sub-assemblies. The labor and operations to process the component or sub-assemblies must be included in each sub-assembly as if each assembly were purchased from a separate supplier and the car was assembled as a finished product.

Manufacturing and Cost Analysis Example

Area or Commodity	Part Name	Description / Model # or Part #	Purchased or Manufactured (P or M)	Quantity	What you paid	Retail Cost Each	Unit of Measure	Supplier's Name and Phone Number	Total Retail Cost
Commodity Name from Appendix A4	Items required in each section are listed in Appendix A4								= Quantity x Retail Cost Each
① Brake Sys	"Widget A"	#304A	P	3	\$ 12.00	\$ 15.00	Each	Amalgamated Auto	\$ 45.00
② Brake Sys	"Widget A"	Alter Widget A	M	3	—	\$ 5.83	Each	Whatsamatta U.	\$ 17.50
③ Brake Sys	"Widget B"		M	1	\$ 15.54	\$ 15.54	Each	Whatsamatta U.	\$ 15.54
Brake Sub-total			—>>	—>>					
Sub-Total for each Area or commodity									
④ Assembly Cost			M	x	\$	y	unit		\$ x*y
Grand Total of vehicle									\$\$\$

SCHOOL _____

CAR NUMBER _____

PRESENTATION JUDGING

Score the following categories on the basis of 0-10 points each according to the following scale (any number or fraction along this scale may be used).

- 0.0 = inadequate or no attempt
- 2.5 = attempted but below expectation
- 5 = average or expected
- 7.5 = above average but still lacking
- 10 = excellent, perfectly meets intent

_____ **CONTENT:** Were the concepts presented appropriate and adequate to explain how the car meets the intent of the customer? Were enough technical details presented without being boring?

_____ **ORGANIZATION:** Were the concepts presented in a logical order progressing from basic concept and showing how the engineering accomplished the concept? Was it clear to the audience what was to be presented and what was coming next? Were distinct introduction and overviews as well as summary and conclusions given?

_____ **VISUAL AIDS:** Were visual aids used or clear visual references made to the car? Were the illustrations visible for all of the audience?

_____ **DELIVERY:** Did the presenter speak in a clear voice? Did the presenter show enthusiasm and promote confidence in the technical aspects? Did he maintain eye contact?

_____ **QUESTIONS:** Did the answer illustrate that the team fully understood the question? Is there doubt that the team understood the answer? Did the team promote complete confidence in their response to the questions?

_____ **TOTAL = PRESENTATION POINTS (50 points maximum)**

COMMENTS: _____

SCHOOL _____

CAR NUMBER _____

DESIGN JUDGING

_____ **AESTHETICS (0-5)** - Does the vehicle look attractive? Does it have a high performance appearance?

_____ **MECHANICAL DESIGN (0-20)** - Do components appear to have been sized properly for the load? Does form follow function? Do brackets serve more than one purpose?

_____ **CHASSIS DESIGN (0-30)** - Does the suspension design consider kinematics, roll center placement or load transfer? How was vehicle handling designed for and developed? How was brake system designed? Was weight distribution and C.G. height optimized?

_____ **MANUFACTURABILITY (0-10)** - Can 4 units per day be produced economically? Was manufacturing and ease of assembly a major consideration?

_____ **SERVICEABILITY (0-15)** - Is the engine easy to service or remove? Is the suspension easy to adjust?

_____ **INNOVATIVENESS (0-15)** - Are any of the components or systems unique? Do the innovations add to the product's functions?

_____ **ERGONOMICS/INTERIORS/SAFETY (0-20)** - Is the vehicle designed to accommodate & function with a wide variety of body sizes? Are controls and instruments easy to use? Does the design consider occupant safety beyond the requirements?

_____ **POWERTRAIN (0-30)** - Does the engine have significant modifications with respect to fuel injection, turbocharging, intake or exhaust? Was the drivetrain well done? Were throttle, drive controls designed well?

_____ **BUILD QUALITY (0-5)** - Fit and finish, quality of materials, detail work, quality appearance.

_____ **MISCELLANEOUS (0 to -50)** - If this is a carry over from last year and did not undergo significant improvements, or if the team does not exhibit a good understanding of the car, then a penalty may be applied.

_____ **TOTAL = DESIGN POINTS (150 points maximum)**

COMMENTS _____

ACTION DEADLINES

1. **REGISTRATION FORM/STATEMENT OF COMPLIANCE** **JANUARY 31, 2001**
Send with payment to:
2001 FORMULA SAE
EDUCATIONAL RELATIONS
SAE INTERNATIONAL
400 COMMONWEALTH DRIVE
WARRENDALE, PA 15096-0001
FAX: (724) 776-0890 *CREDIT CARD PAYMENTS ONLY*

2. **SAFETY STRUCTURE EQUIVALENCY FORM** **MARCH 1, 2001**
See Section 3.3.2
Send via mail or fax to:
KATHLEEN MCDONALD
CREATIVE CONSULTING SERVICES
1280 EAST BUELL
OAKLAND TWP., MI 48306
FAX: (248) 601-8934

3. **COST REPORT** **APRIL 3, 2001**
See Section 4.4
Send via mail to:
ATTN: SUZY ZUKOWSKI
TEAM FSAE™ - DAIMLERCHRYSLER CORPORATION
CIMS: 483-01-14
800 CHRYSLER DRIVE EAST
AUBURN HILLS, MI 48326-2757

4. **PRE-EVENT DESIGN REVIEWS** **APRIL 3, 2001**
See Section 4.6
Send via mail, e-mail, or fax to:
SHANIN HART
SAE EDUCATIONAL RELATIONS
400 COMMONWEALTH DRIVE
WARRENDALE, PA 15096-0001
FAX: 724-776-0890
E-MAIL: HART@SAE.ORG

