TSAE Auto Challenge 2025 Student Formula

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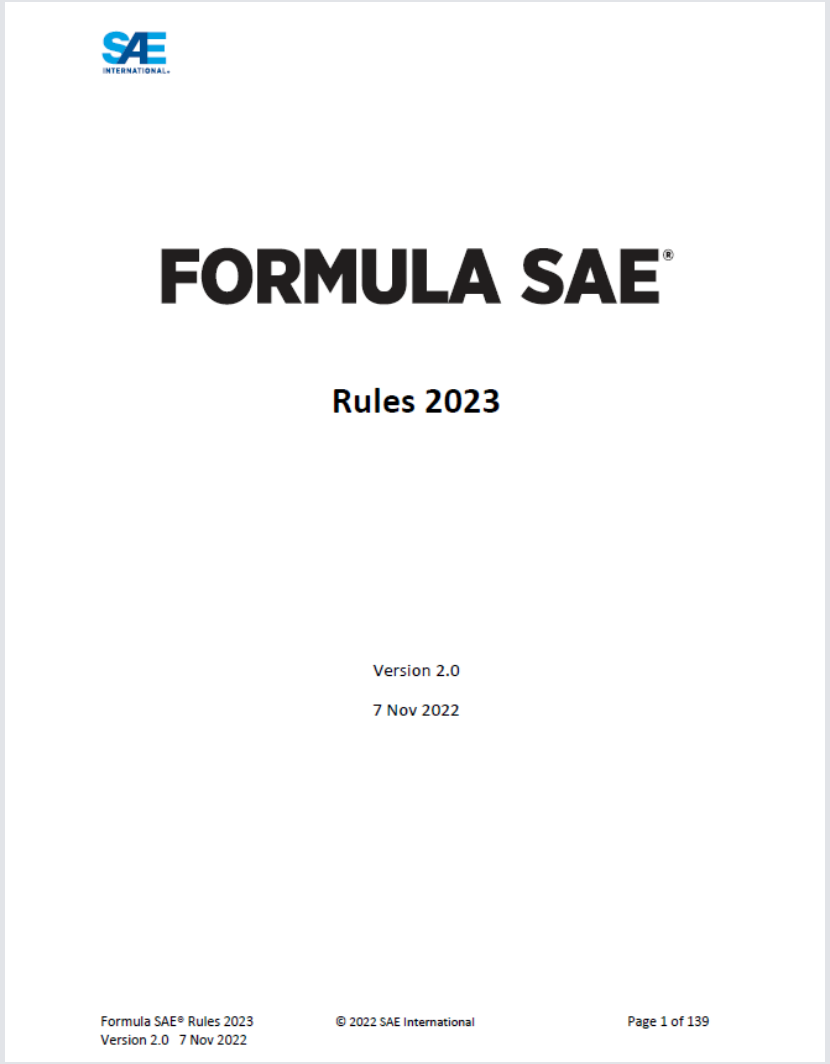
FORMULA SAE Rules 2023



FORMULA SAE®

Rules 2023

Version 2.0

7 Nov 2022

Formula SAE® Rules 2023
Version 2.0 7 Nov 2022

Cost and Manufacturing Event

Objective

The Cost and Manufacturing Event evaluates the ability of the team to consider budget and incorporate production considerations for production and efficiency.

Making tradeoff decisions between content and cost based on the performance of each part and assembly and accounting for each part and process to meet a budget is part of Project Management.

Cost and Manufacturing Event

Cost Report

- List and cost every part on the vehicle using the **standardized Cost Tables**.
- Base the cost on the actual manufacturing technique used on the prototype.
- Cast parts on the prototype must be cost as cast, and fabricated parts as fabricated, etc.
- Include Tooling Cost (welding jigs, molds, patterns and dies) for processes requiring it.
- **Exclude** R & D and capital expenditures (plant, machinery, hand tools and power tools).
- Include supporting documentation to allow officials to verify part costing – i.e. **complete engineering drawing !!**
- **Don't forget to include COST SUMMARY in every Cost Report**

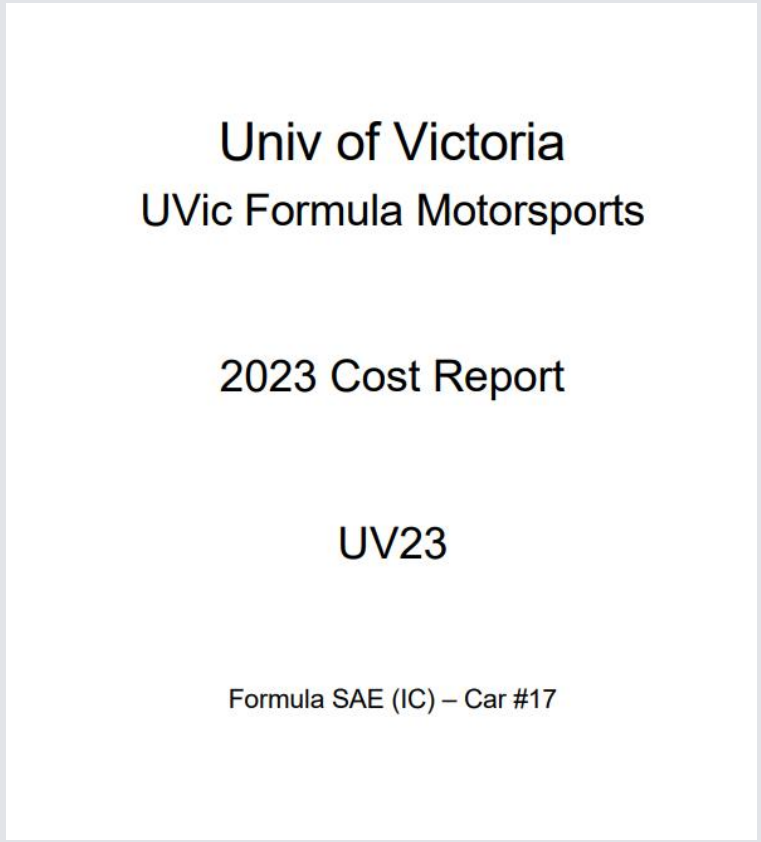
Cost and Manufacturing Event

Bill of Materials – BOM

- The BOM is a list for every vehicle part, showing the relationships between the items.
  a) The overall vehicle is broken down into separate Systems
  b) Systems are made up of Assemblies
  c) Assemblies are made up of Parts
  d) Parts consist of Materials, Processes and Fasteners
  e) Tooling is associated with each Process that requires production tooling

Cost and Manufacturing Event

Example of Cost Report



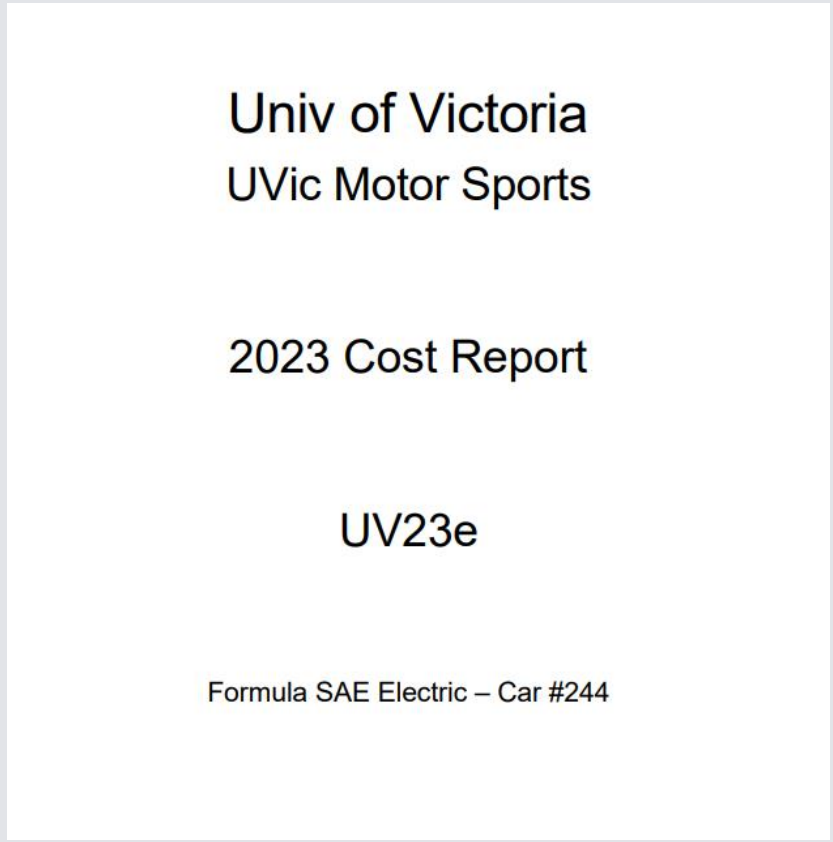
Univ of Victoria

UVic Formula Motorsports

2023 Cost Report

UV23

Formula SAE (IC) – Car #17



Univ of Victoria

UVic Motor Sports

2023 Cost Report

UV23e

Formula SAE Electric – Car #244

https://www.fsaeonline.com/page.aspx?pageid=9f27c091-8f3d-4afa-8a82-a7d14af80741

Cost and Manufacturing Event

Cost Addendum

- A supplement to the Cost Report that reflects any changes or corrections made after the submission of the Cost Report may be submitted.
- The Cost Addendum must be submitted during Onsite Registration at the Event.
- Changes to the Cost Report in the Cost Addendum will incur additional cost:
  a) Added items will be cost at 125% of the table cost: + (1.25 x Cost)
  b) Removed items will be credited 75% of the table cost: - (0.75 x Cost)

Cost and Manufacturing Event

Real Case Scenario

- You are the lead engineer for a small company producing formula style racecars. Your management team has asked you to **reduce the total cost of the system by 15%** to meet profit goals for this quarter.
  - What changes were made to reach the 15% cost savings goal? Present modified cost report pages with any changes made.
  - How did these changes impact other aspects of your car (weight distribution, braking speed, max Gs, etc.)? Prepare an engineering analysis of the largest changes made to the car and how they impact performance, either positively or negatively.

Cost and Manufacturing Event

Real Case Scenario (continued)

- **Discussion will be for 15 minutes onsite**. No submissions are needed before the onsite event.
- Allowable communication forms are as follows:
  - Short PowerPoint (note the time constraint)
  - Spreadsheet data, calculations, and graphs
  - Design board

Structural Equivalency Spreadsheet – SES

- The SES is a supplement to the Formula SAE Rules and may provide guidance or further details in addition to those of the Formula SAE Rules.
- The SES provides the means to:
  a) The properties of tubes and laminates may be combined to prove Equivalence.
  b) Determine Equivalence to Formula SAE Rules using an accepted basis

Structural Equivalency Spreadsheet – SES

Equivalence

- Equivalency in the structural context is determined and documented with the methods in the SES
- Any Equivalency calculations must prove Equivalency relative to Steel Tubing in the same application
- The properties of tubes and laminates may be combined to prove Equivalence.
  For example, in a Side Impact Structure consisting of one tube per F.3.2.1.e and a laminate panel, the panel only needs to be Equivalent to two Side Impact Tubes.

Structural Equivalency Spreadsheet – SES

Tubing Requirements

	Application	Steel Tube Must Meet Size per **F.3.4**:	Alternative Tubing Material Permitted per **F.3.5** ?
a.	Front Bulkhead	Size B	Yes
b.	Front Bulkhead Support	Size C	Yes
c.	Front Hoop	Size A	Yes
d.	Front Hoop Bracing	Size B	Yes
e.	Side Impact Structure	Size B	Yes
f.	Bent / Multi Upper Side Impact Member	Size D	Yes
g.	Main Hoop	Size A	NO
h.	Main Hoop Bracing	Size B	NO
i.	Main Hoop Bracing Supports	Size C	Yes
j.	Driver Restraint Harness Attachment	Size B	Yes
k.	Shoulder Harness Mounting Bar	Size A	NO
l.	Shoulder Harness Mounting Bar Bracing	Size C	Yes
m.	Accumulator Protection Structure	Size B	Yes
n.	Component Protection	Size C	Yes
o.	Other Structural Tubing	Size C	Yes

	Tube	Minimum Area Moment of Inertia	Minimum Cross Sectional Area	Minimum Outside Diameter or Square Width	Minimum Wall Thickness	*Example Sizes of Round Tube*
a.	Size A	11320 mm^4	173 mm^2	25.0 mm	2.0 mm	*1.0" x 0.095" 25 x 2.5 mm*
b.	Size B	8509 mm^4	114 mm^2	25.0 mm	1.2 mm	*1.0" x 0.065" 25.4 x 1.6 mm*
c.	Size C	6695 mm^4	91 mm^2	25.0 mm	1.2 mm	*1.0" x 0.049" 25.4 x 1.2 mm*
d.	Size D	18015 mm^4	126 mm^2	35.0 mm	1.2 mm	*1.375" x 0.049" 35 x 1.2 mm*

Structural Equivalency Spreadsheet – SES

Alternative Tubing Materials

- If any Alternative Materials are used, the SES must contain:
  a) Documentation of material type, (purchase receipt, shipping document or letter of donation) and the material properties.
  b) Calculations demonstrating equivalent to or better than the minimum requirements for steel tubing in the application as listed in F.3.4.1 for yield and ultimate strengths matching the Non Welded Steel properties from F.3.4.2.a above in bending, buckling and tension, for buckling modulus and for energy dissipation.

Structural Equivalency Spreadsheet – SES

Composite and Other Materials

- If any composite or other material is used, the SES must contain:
  a) Documentation of material type, (purchase receipt, shipping document or letter of donation) and the material properties.
  b) Details of the manufacturing technique and/or composite layup technique as well as the structural material used (examples - cloth type, weight, and resin type, number of layers, core material, and skin material if metal).
  c) Calculations demonstrating equivalence of the structure to one of similar geometry made to meet the minimum requirements for a structure made from steel tubing per F.3.2. Equivalency calculations must be submitted for energy dissipation, yield and ultimate strengths in bending, buckling, and tension.

Structural Equivalency Spreadsheet – SES

Composite and Other Materials (cont.)

- If any composite or other material is used, the SES must contain:
  d) Construction dates of the test panel(s) and monocoque, and approximate age(s) of the materials used.

  The intent is for the test panel to use the same material batch, material age, material storage, and student layup quality as the monocoque.

Structural Equivalency Spreadsheet – SES

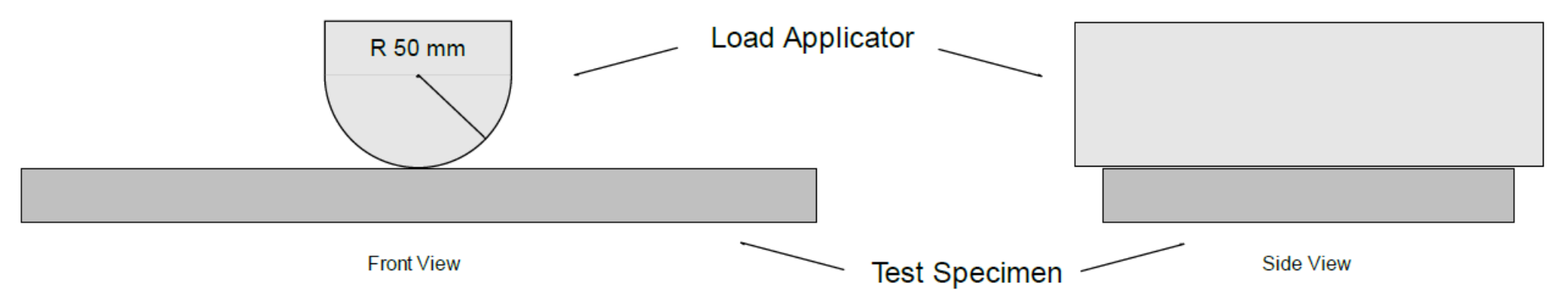
Quasi-Isotropic Layup

- A layup with equal fiber strength and stiffness along any orientation in the plane of the layup.
- When a layup has equal fiber properties and mass in the 0/90/+45/-45 directions, the layup may be considered Quasi-Isotropic

Structural Equivalency Spreadsheet – SES

Laminate Testing

- The same set of test results must not be used for different monocoques in different years.
- Primary Structure Laminate Testing (3-point bending tests)
- Comparison Test



Structural Equivalency Spreadsheet – SES

Laminate Testing

- Perimeter Shear Test
- Lap Joint Test
- Additional Testing - When a laminate schedule(s) are NOT a Quasi-Isotropic Layup (F.4.2):
  a) Results from the 3 point bending test will be assigned to the 0 layup direction.
  b) The monocoque must have the tested layup direction normal to the cross sections used for Equivalence in the SES, with allowance for taper of the monocoque normal to the cross section.
  c) All material properties in the weakest direction must be 50% or more of those in the strongest direction as calculated by the SES.

Structural Equivalency Spreadsheet – SES

Accumulator Container (EV ONLY)

- All Accumulator Containers must be:
  a) Designed to withstand forces from deceleration in all directions
  b) Made from a Nonflammable Material (F.1.18)
- Design of the Accumulator Container must be documented in the SES.
  Documentation includes materials used, drawings/images, fastener locations, cell/segment weight and cell/segment position.
- The Accumulator Containers and mounting systems are subject to approval during SES review and Technical Inspection.