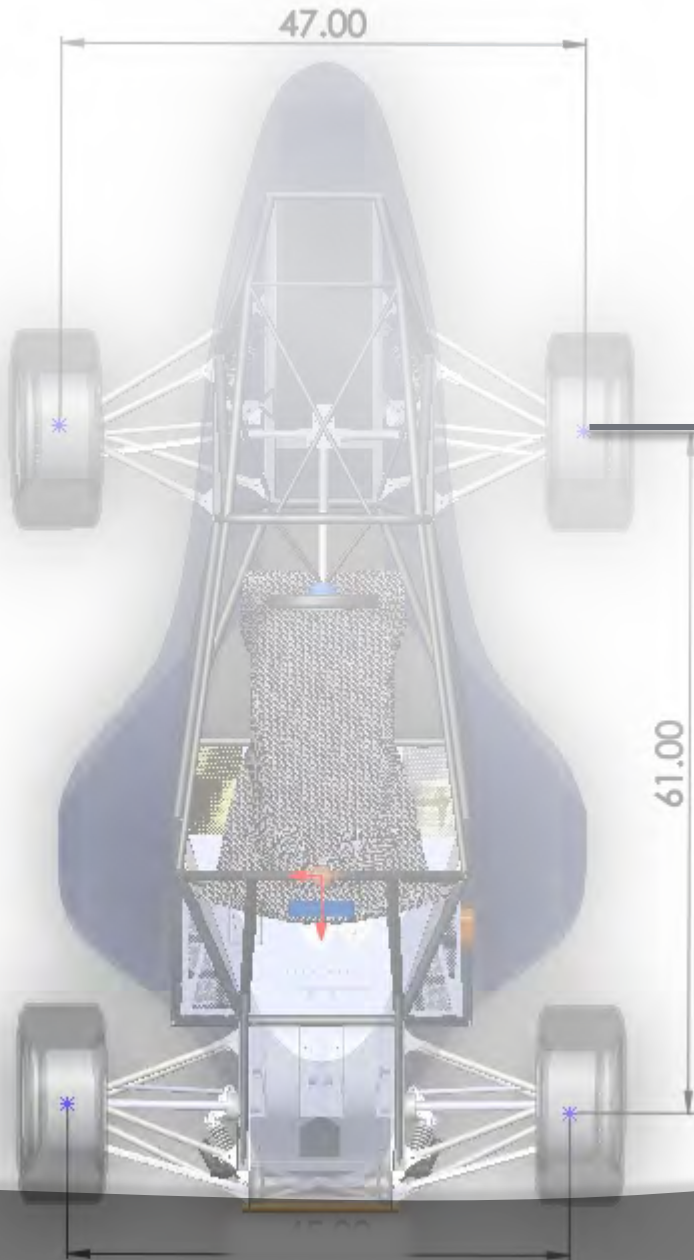


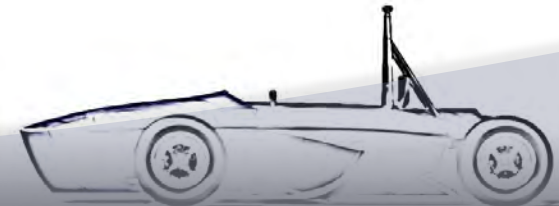
Testing & Development



Suzanne & Michael Royce
Albion Associates LLC

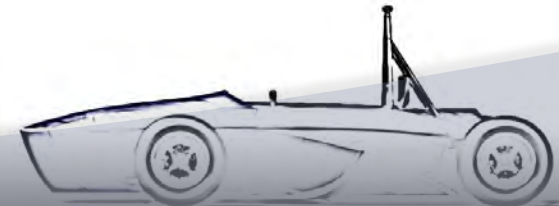
Agenda

- Why test?
- Things that **MUST** be done before leaving the workshop
- Types of testing
- The test site
- Test equipment
- Test planning
- Data acquisition



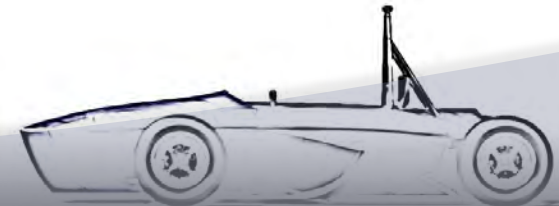
General

- Testing is mandatory for 4 reasons:
 - Driver familiarization and training
 - To check & improve durability and reliability
 - For tuning, set up and development
 - To provide data for use in the Design Event



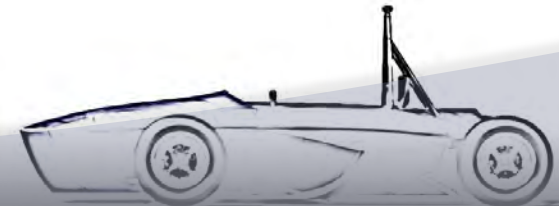
Driver Training

- Every driver MUST have a government issued driver's license
- Driving an FSAE car is very different from driving your road car.
 - Power to weight
 - Could be a 2 pedal car versus normal 3 pedal
 - Sequential gearbox
- For any driver to do well, seat time is vital.
- Many teams arrive at competition with drivers who have never sat in the car, let alone driven it!
- Get ALL drivers in the car, including back ups
- Adjust seat belts and head restraint
- Practice egress



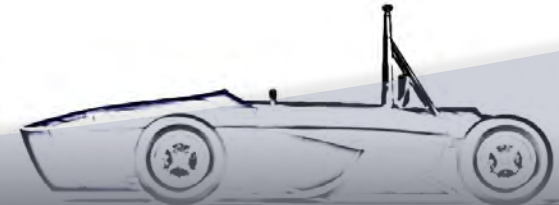
Driver Training – cont'd

- Check ergonomics, comfort is important
- 15 minutes driving the Endurance Event is tiring
- Kart practice is worthwhile, but not a substitute
- Acceleration Event
 - Need to practice starts as front of car only 0.3 metres from the timing line
- Skid Pad Event
 - Need driveability and controlability
 - Need to know which direction
 - How many laps
 - How and where to exit
 - Get it wrong and DNF!



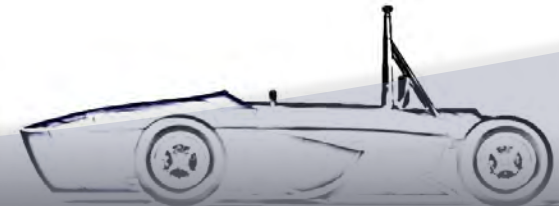
Durability

- No part, component or car gets to production without testing and development
- Car built of individual parts, weakest part is weakest link
- Initial design will be:
 - a. Under designed and fail
 - b. Overdesigned and be too heavy/costly
 - c. Just right
- Chances of “c” are minimal!!
- Only about 35% of cars that start Endurance survive the 22 kms for FSAE & FS! It is 44 kms for Formula Hybrid!
- Majority of these cars have been tested
- Very often at FS, 50% of THE TOP 10 cars starting Endurance fail to finish!



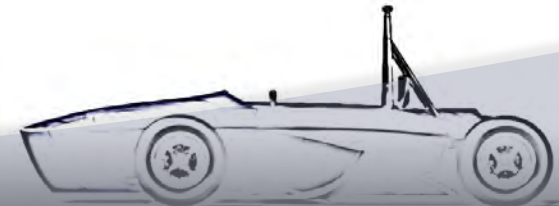
Mandatory Tests before Leaving for the Competition

- Brake test
 - Lock all 4 wheels, controlled stop
 - Use old tyres (or some street tyres) for test at home, official “dry” tyres at the competition (an old set is acceptable)
 - Very severe test on steering & suspensions
 - Finds the weaknesses
 - Many suspensions break at competitions
 - No pass = no dynamic events
- Noise test
 - Simple test
 - Aim for 3 dB below the limits on each test
 - Fixing at the Competition very difficult
 - No pass = no dynamic events



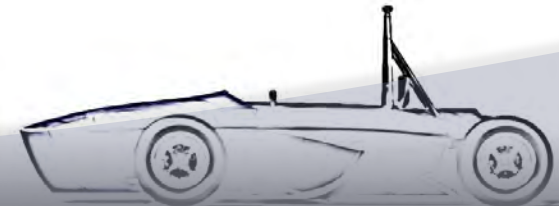
Development & Tuning – Powertrain

- Need to check and tune
 - Engine steady state calibration (fuel and spark)
 - Engine transient calibration (fuel and spark)
 - Cold start calibration
 - Hot start calibration
 - Driveability
 - Cooling system performance (water temperature)
 - Oil system performance (e.g. oil pressure when cornering)
 - Fuel system performance (e.g. fuel temperature, fuel pick up)
 - Leaks



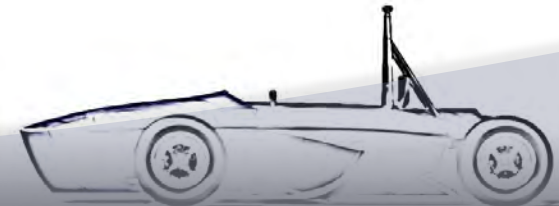
Development & Tuning – Powertrain – cont'd

- Peak power is not too important
- Driveability is vital
 - Skid Pad is a low speed event (50 points)
- Cold and hot start calibrations are VITAL
- Fuel economy is important
- Steady state tuning on a dyno is good for a base calibration
- Transients, base on dyno tests, but tune in the car.



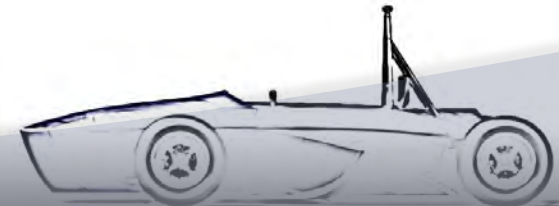
Development & Tuning Chassis Variables

- Suspension set up:
 - Springs
 - Dampers
 - Sway bars & settings
 - Camber
 - Toe in/out
 - Ride height
- Tyre pressures
- All of the above for both front & rear!
- Brake bias, front to rear



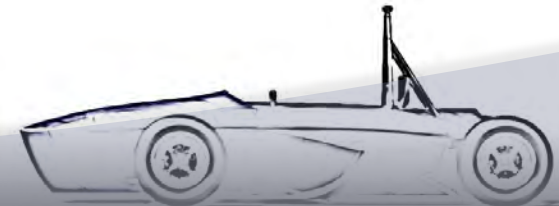
Data for the Design Event

- The Design Judges are looking for test data
- And they want you to explain it
- If you have not tested and have no test data, you will not score well in the Design Event



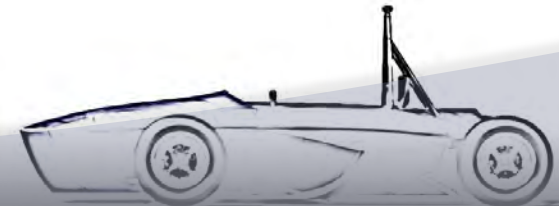
Testing

- Test time is precious
- Have a designated “test manager”
- Define the reason for the test
- Develop test goals
- Must have a (written) test plan
- Plan what changes to make
- Make incremental changes
 - Can do a DOE but 1 change at a time is easier to follow
- Always know what the baseline settings are so can return to them
- Record all the settings and results
- Write down all the changes and the results
 - Measurable and driver impressions



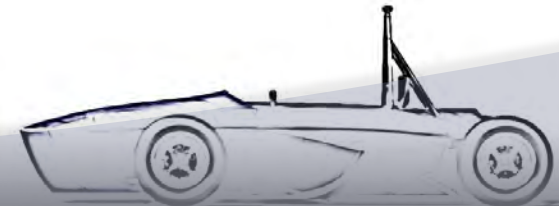
The Test Site

- Find a site without obstacles or parked vehicles
- Get permission
- Suggested set ups:
 - Initial
 - Circle for steady state handling/suspension set up
 - Slalom for transient handling
 - Later
 - Acceleration course
 - Then a Skid Pad
 - Mini autocross course



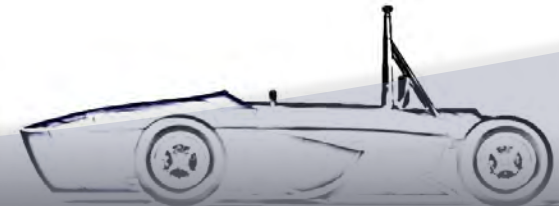
Test Equipment, etc

- Pylons
- Stop watches
- System to record video
- Jack
- Jack stands
- Tools, including:
 - Tyre pyrometer
 - Tyre pressure gauge
- Radios for communications around the course
- Fire extinguishers (and know how to use them)
- Safety plan (how to get to the nearest hospital, etc.)
- A person with first aid training is a plus



Data Acquisition

- Many modern ECU's have built in data acquisition capability
- Can be fairly simple
- Can help with:
 - Chassis development
 - Engine calibration (really needs wide band O₂ sensor)
 - Driver training
- Build a channel list from your goals



Data Acquisition – cont'd

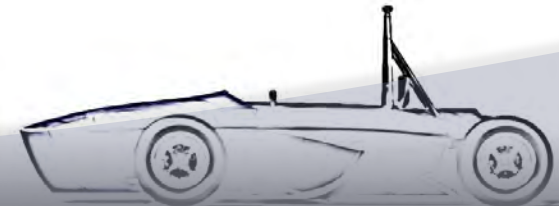
- Sensors (in no particular order)
 - Engine speed
 - Throttle position
 - Car speed
 - Engine oil pressure
 - Engine oil temperature
 - Water temperature
 - Lateral acceleration
 - Longitudinal acceleration
 - Fuel pressure
 - Fuel temperature
 - Injector pulse width
 - Brake on/off
 - Spark advance
 - Gear
 - Wheel speed (multiple?)
 - Suspension movement
 - Steering angle
 - Wide band O₂ sensor(s)
 - Exhaust gas temperature



Data Acquisition – cont'd

- Select your sensors, location & type
 - Select your data logger (if not in your ECU or dash unit)
 - Collect the data
 - Post-process the data
-
- Collegiate Roadshow “Data Acquisition” presentation by Frank Whiton at:

<http://students.sae.org/cds/formulaseries/roadshow.htm>



Questions?





Copyright © 2015 Albion Associates, LLC.

All rights reserved.

