SAE DETROIT SECTION

FSAE Workshop 2012

FSAE Design Considerations

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Design Considerations

- General Design Process
- Important Considerations
- Qualitative “Rules”
- Things to Ask During All Project Phases
- Design Trends
- Q & A

General Design Process

- Starting point? -Rules, Tires, Scores, Lessons Learned…
- On a per event basis, what are your goals?
- What performance specs will meet those goals?
- Break car into systems and work down
- Big picture overrides all else- Integration, integration, integration
- Complete vehicle lay-out (mass & CG of every bit)
- Synthesis- every component, it's interactions
- Weight distribution and CG are more than a spec
- Iterate through systems integration issues

Important Considerations

- K.I.S.S. vs. High Tech
- Tire Data – FSAE Tire Test Consortium
- Data Acquisition – engineering and driver tool
- Mass vs. Stiffness - A balancing act
- Itty bitty parts – mass vs. reliability
- Materials – carbon=cool, but is it the right choice?
- Modeling and analysis vs. physical testing

Design Complexity

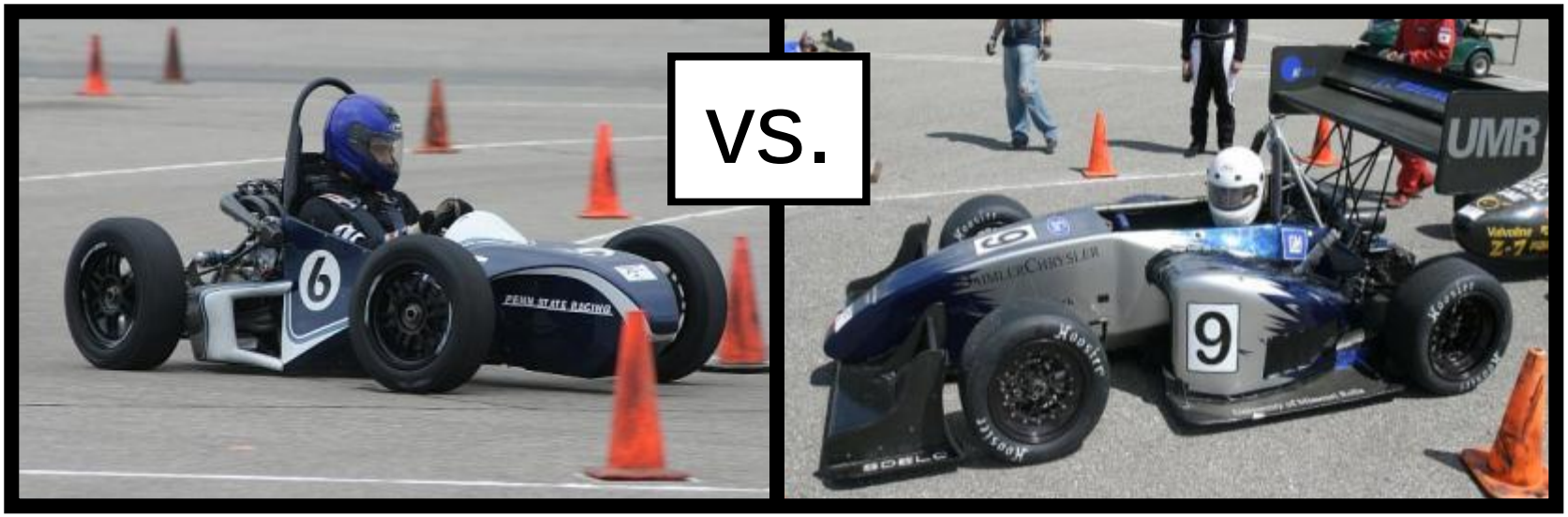
Both do the same job…

What are the performance gains vs. cost, effort, and mass trade-offs?

Aerodynamics

You must consider:

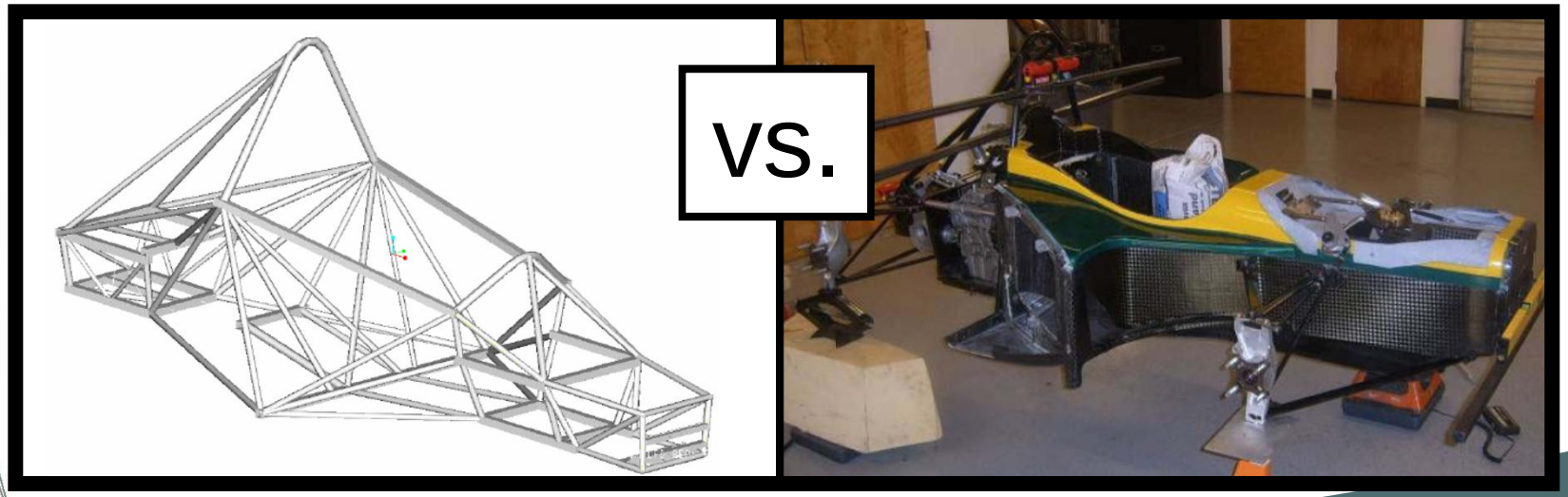
- Time and expense to design and build vs. REAL benefits
- development time
- mass effects
- actual competition benefits (stopwatch and judges)



Composites

You must consider:

- Time and expense to design and build vs. REAL benefits
- Analysis capability, can you predict your performance?
- Development time
- Cost & mass effects
- Composites are *very* process sensitive, allow time to build it twice
- When problems are found in tech, what is plan B? Upfront integration.



Qualitative Design "Rules" to keep in mind

- Good design → If it looks right it usually is
  - Corollary → If it looks wrong, well…
- Good load paths are your friend
  - Triangles (really tetrahedrons) = good load paths
- The part not on the car has zero mass, no cost and can't fail
  - The reward in performance must outweigh the risk and penalty
- Systems Engineering → Know it, Love it, Live it
- Engine calibration → Not just about air/fuel… Spark it right, always. It's a huge knob for engine performance.
- Mass → *Mass begets mass*. There is no minimum weight.
  - Make it *light*. But broken parts rarely win races.

Things to Ask During All Project Phases

- Does the car look like it was designed with a systems focus?
- What parts look like after thoughts? Were they?
- Is packaging tidy and look planned?
- Are items such as wiring exposed or neatly routed in looms?
- Are components adequately protected from environment
  - heat, chaffing, impact, vibration
- Is the car reasonable to maintain and adjust?
- Is the car on track to mass, CG and packaging expectations? Why?
- Tuning? Can discrete adjustments be made?

Good Packaging Examples

Well thought out,

Well integrated, and

Few surprises.

This is where the

Upfront work pays off!!

Often Overlooked Design Details

- Fasteners- quality, grip lengths, common…
- Welding- correct fillers
- Composites- epoxy selection
- Engine Design / Calibration- part throttle
- Cooling system- heat rejection
- Wiring- neat looms, proper gauge, shielding

Resources

- The Rules… KEY: know them inside and out
- SAE Website- links to papers, guides, etc…
- Carroll Smith Books- cheap, practical, good reads
- Race Car Vehicle Dynamics- Milliken
- Learn & Complete- A Primer for FSAE- Royce & others
- FSAE Tire Test Consortium- www.millikenresearch.com/fsaettc.html
- Claude Rouelle Seminars
- www.fsae.com –book list (search the forums)
- numerous FSAE specific papers out there
- See handout for additional list of resources

Questions ?

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