

FSAE Judging



What you've always wanted to know



Kaz Technologies

- Kaz Technologies was started in 1995
- We have a staff of 7 engineers
 - Over 91 years of combined racing and automotive engineering experience
- GM Racing
 - Resident 7-post and shock technical specialists
 - 7-post testing for GM racing
 - 7-post & damper testing tools
 - Race Engineering
- What else do we do?
 - Race Engineering for Stevenson and Dodge Viper
 - Damper design and development
 - Damper sales and service

Kaz Technologies Website

YOUR information resource



The screenshot shows the Kaz Technologies website home page. The header features the company logo and navigation links: Links, e-News Sign Up, Shopping Cart, and Contact. A search bar is also present. Below the header is a navigation menu with categories: WHY KAZ TECH?, KAZ TECH TIPS, FORMULA SAE, RACE ENGINEERING, ROAD VEHICLE ENG, SHOCK SERVICES, DOWNLOADS, and STORE. The main banner area displays 'Formula SAE' with a background image of a race car. Below this, the 'Formula SAE' section is highlighted, featuring a sidebar with links to FSAE Information Center, FSAE Shock Services, Shocks, Shock Parts & Tools, Shock & Dyno Services, Springs, Torus Bearings, Brake Rotors, and FAQs. The main content area is titled 'FSAE INFORMATION CENTER' and includes a welcome message, a brief description of the center's purpose, and a list of 'FSAE Resources' with links to the New FSAE Site, SAE Official FSAE Page, Official FSAE Team Blog Site, and Kaz Tech Tips.

KAZ TECHNOLOGIES

Links | e-News Sign Up | Shopping Cart | Contact

WHY KAZ TECH? | KAZ TECH TIPS | FORMULA SAE | RACE ENGINEERING | ROAD VEHICLE ENG | SHOCK SERVICES | DOWNLOADS | STORE

Formula SAE

FSAE INFORMATION CENTER

Welcome to your center for information! We have all the latest FSAE news, and links to help YOU!

Here at Kaz Technologies, we strive to give you the latest information to help you with your competitions.

FSAE Resources:

- New FSAE Site for Downloads and Rules
<http://www.fsaonline.com/>
- SAE Official FSAE Page
<http://students.sae.org/competitions/formulasae/>
- Official FSAE Team Blog Site
<http://fsae.com/>
- Kaz Tech Tips
<http://www.kaztechnologies.com/kaztech-tips/>



The screenshot shows the Kaz Technologies website Tech Tips page. The header is identical to the home page. The navigation menu is the same. The main banner area displays 'KAZ TECH TIPS' with a background image of a race car. Below this, the 'Kaz Tech Tips' section is highlighted, featuring a sidebar with links to Why Shocks are Important, Tip-top Shock Tips, Why Check Gas Pressure in your Shocks, 7-Post Testing, and A Guide To Your Dampers. The main content area is titled 'KAZ TECH TIPS' and includes a welcome message, a brief description of the tips, and a list of 'Kaz Tech Tips' with links to the New FSAE Site, SAE Official FSAE Page, Official FSAE Team Blog Site, and Kaz Tech Tips.

KAZ TECHNOLOGIES

Links | e-News Sign Up | Shopping Cart | Contact

WHY KAZ TECH? | KAZ TECH TIPS | FORMULA SAE | RACE ENGINEERING | ROAD VEHICLE ENG | SHOCK SERVICES | DOWNLOADS | STORE

KAZ TECH TIPS

Welcome to Kaz Tech Tips.

We're here to help you get the most from your racing experience. With our combined 60 years of education, experience, wins and yes, sometimes losses, we will give the tips to get you around the track FAST and in the winner's circle. Consider us your resource for technology, information and solutions.

We plan to post new Kaz Tech Tips regularly to keep you informed. If there's something on your mind, or a question you can't find an adequate answer to, please send it to us and we'll get you an answer. [Email us today with your question.](mailto:info@kaztechnologies.com)

Check Kaz Tech Tips often! And go FAST!

Steering Rack

High quality steering racks from Kaz Technologies are now available. We have teamed up with Earnhardt Technologies Group to design and build a high quality steering rack for FSAE and small racing classes. Check out the features, specs and accessories for this rack and I am sure you will agree that it was well worth the wait.



Features- Price is \$670.00

- Front and rear low friction bushings on pinion gear shafts provide the support to eliminate lash
- Same low friction bushings guide the rack through to provide smooth operation while eliminating lash.
- Pinion shaft and rack seals to keep the dirt and moisture out.
- Adjustable trunion blocks along the rack tubes provide multiple mounting options and rack rigidity.
- 3/8-24 internal threaded rack extensions allow for a clevis or rod end of your choice.
- Tune-able travel stops to customize your steering requirements.
- Adjustable rack preload and lash.
- Optional integrated steering sensor.
- Weight: 3 lbs
- Rack Travel: 3.25 inches with standard rack extensions and 1/8 inch stops
 - 3.25 inch rack travel at 246 deg of pinion rotation
 - Rack travel for one revolution of the pinion is 4.75 inches

Steering Rack Accessories

Accessories

- Clevis Ends
- High Performance Steering Sensor
- Race Quality Pinion U-joint



U-Joint
Price: \$89.00 Each



Sensor
Potentiometers
Price: \$99.00

Special features:

Long life

Converts rotary movement into proportional voltage

The bearings are protected by a special high-grade temperature resistant plastic material

Electrical conductors are sealed into the housing; keeping dirt and moisture out.

An elastomer-damped precious metal multi-finger wiper ensures reliable contact even under the severest of working conditions.

Wiring Harness

The quality of FSAE products from Kaz Technologies continues with the introduction of our FSAE Chassis Harness. Each harness is constructed according to the racing industry standards; using racing components. We use waterproof DTM connectors and completely shrink wrap and seal every junctions. If you ever have to trace a certain wire, we make it easy by labeling each wire and providing a complete pin-out table and component location list. It doesn't get any easier

When you calculate your time, efforts and materials in making a harness and then add in the time to trouble shoot the problems, you will soon discover the Kaz Technologies Chassis Harness is the best choice. Your time is better spent working on other features for your car.



**FSAE Chassis Harness
Assembly**

Price: \$2699.00

Wiring Harness Documentation

Pin-Out Table:

A complete pin-out table is provided with each harness. This table lists every connector with wire gauge, color and description for each pin. With this table it makes it very easy to trace wirings for troubleshooting, making changes or component additions.

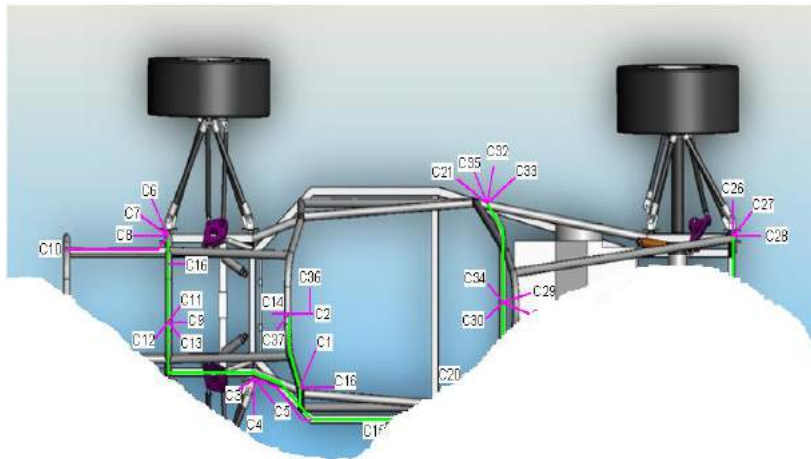
Kaz Technologies FSAE Chassis Harness Pin-Out Table

C1 Switch Panel			Conn:	Boot:	GlueShrink							
			Backshell:									
Pin #	Conn. Pin Size	Description	Color	Gauge	Connects To:							
					A	B	C	D	E	F	G	
C1-1	18	12 Volt Master (SW Panel,Spare)	Red	20	C31-2						SPL @ C31	
C1-2	18	Starter Relay SW input	Ppl	24	C19-1							
C1-3	18	Neutral Light Out	Gm	24	C30-2							
C1-4	18	Oil Light Out	Brn	24	C30-1							
C1-5	18	Up Shift	Yel	26	C30-3							
C1-6	18	Down Shift	Yel/Blk	26	C30-4							
C1-7	18	SW 1 (Display Mode/Alarm)	Wht/Red	26	C2-57							
C1-8	18	SW 2 (Display Scroll/Fuel Reset)	Blu/Wht	26	C2-58							
C1-9	18	SW 3 (Logger Active)	Gm/Wht	26	C2-59							
C1-10	18	0 Volt (Switches)	Blk/Wht	24	C2-56							
C1-11	18	Launch/TC Active	Org/Wht	26	C30-5							
C1-12	18	0 Volt ECU	Blk	20	C30-12						Spl @ C30	
C2 Display (Data)			Conn:	Boot:	202K163							
			Backshell:									
Pin #	Conn. Pin Size	Description	Color		Connects To:							
							D	E	F	G		
C2-1	22	AV 15										
C2-2	22	AV 16										
C2-3	22	AV 17 (X Axis)										
C2-4	22	AV 18 (Y Axis)										

Wiring Harness Documentation

Chassis Component Locations:

Our harnesses were designed to fit a standard FSAE chassis. So to help you preplan the layout of your components and then to find the connector and what component is connected to that connector, we created a Chassis Component Location layout. Changing the location of your components is no problem. It is easily done by just extending the pigtail from the connector to the component.



Chassis Harness Component Locations	
C1	SWITCH PANEL
C2	DISPLAY
C3	LF SPEED SENSOR
C4	LF SHOCK
C5	SPARE AV1
C6	RF SPEED SENSOR
C7	RF SHOCK
C8	SPARE AV2
C9	BRAKE LIGHT SWITCH
C10	TRANSPONDER
C20	WATER PUMP
C21	RIGHT RADIATOR FAN
C22	LR SPEED SENSOR
C23	LR SHOCK
C24	SPARE AV3
C25	TAIL BRAKE LIGHT
C26	RR SPEED SENSOR
C27	RR SHOCK
C28	SPARE AV4



Judging Overview

Design Process

As a Design judge, I am looking for a complete design process

- Objectives
- Design process
- Data to validate objectives
 - System/Component testing
 - Vehicle testing

Objectives

Objectives need to be-

- Definitive
- Measurable
 - Physical testing
 - Vehicle performance
- Obtainable by YOUR team

Vehicle Objectives

Start with vehicle design objectives

- Physical objectives
 - Weight
 - Torsional stiffness
 - Horsepower
- Performance objectives
 - Acceleration event time
 - Skid pad time or max lateral acceleration

Chassis Objectives Examples

- Vague
 - Reduce weight from last year's car
 - Torsional stiffness higher than last year
- Better
 - Reduce weight by 10 lbs
 - Increase stiffness by 10%
- Best
 - Chassis weight x lbs
 - Torsional stiffness x

System Objectives

Design objectives for each system in the vehicle

These should mirror the design score sheet

- Suspension
- Frame/Body/Aero
- Powertrain
- Cockpit/Controls/Brakes/Safety
- System Management/Integration

Emphasize how these support your vehicle objectives

Design Process

Outline the process you used to design each system

- Physical and performance objectives for the system
- Design process used
- Simulation/modeling/testing results used as part of the process
- Decisions made along the way and why

Design process documentation

- Clear, concise charts with labels and units
- Simple to read graphs with units
- Data to support design decisions to achieve objectives
- Various alternatives tried

Validation of Objectives

Physical testing

Testing to confirm design meets objectives

- Vehicle weight
- Torsional twist test of chassis
- Engine dyno torque/horsepower curves
- Shock dyno curves
- Coast down testing

Vehicle Performance Testing

- Acceleration test
- Skidpad
- Transient response test
- Etc.

Validation of Objectives

Vehicle Performance Testing

- What changes were made to improve performance and exceed overall vehicle performance objectives?
- Data to support

Be creative with tests and data acquisition methods!

Reasons Didn't Meet Objectives

If you didn't meet your objectives, why?

- What needs to be done to meet objectives
- Lessons learnt
- Further work to be done

Design Considerations



Compliments of Tony Lyscio

Design Complexity

Both do the same job...



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

Aerodynamics

You must consider:

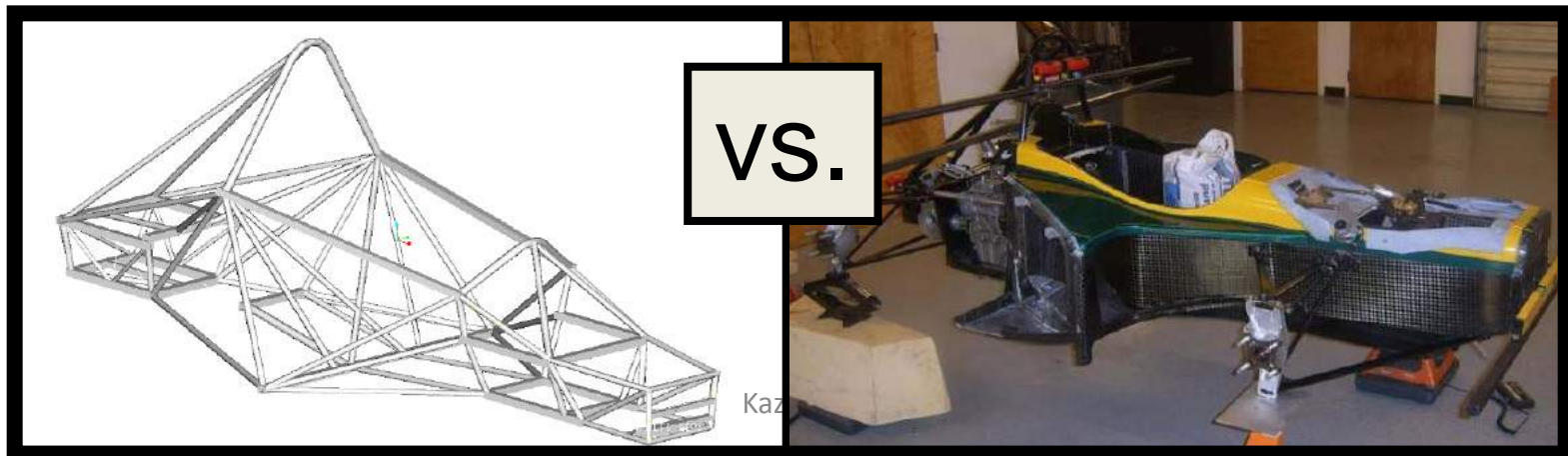
- **Time** and expense to design and build vs. REAL benefits
- development **time**
- mass effects
- actual competition benefits (stopwatch and judges)



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.**



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



Sean O'Shea- Bosch



Sean O'Shea

Experience

- Bosch Motorsport – Sr. Engineer
 - Diesel Project Lead
- Maximum PSI – Owner Co-Founder
 - Performance Automotive Company
- Rypos – Sr Test Engineer
 - Diesel Emissions Test Engineer
- BASF Catalysts – Test Engineer
 - Diesel Emissions Test Engineer

Education

- Rutgers University
 - BS Mechanical Engineering
 - BA Economics
- Kettering University
 - Formula Team 1998 – 2001
 - Clean Snowmobile - 2001



Skills Developed with FSAE

- Fabrication Experience
- Product Design and Development
- Gasoline & Diesel Calibration Experience



Bosch Engineering North America



BOSCH

Typical Projects

→ All engineering success directly related to FSAE





Thank you for your time!
Sean O'Shea - Bosch Motorsport

Bosch Engineering North America

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BOSCH



Tri Gaffney

Driveline Design

Driveline Sizing

- Load Cases & Sizing
 - What load cases where used in the sizing?
 - Firing Load Cases
 - Inertia Load Cases
 - Stiffness Requirements
- Half Shaft (or Solid Axle)
 - Are the half shafts going to stay in the car?
 - CV Articulation Angles (full range of motion)
 - CV Plunge
 - Deflection

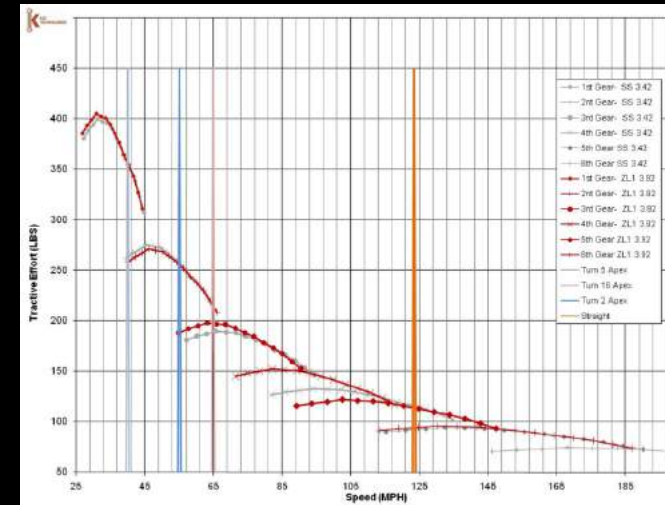
Gearing

- Gear Ratios and Final Drive
 - What are the gear ratios and final drive?
- Adjustability
 - Does it need to be tuned?
 - What are the adjustment ranges?
- Gearing Optimization
 - How have the ratio selections been tuned to the vehicle?
 - How are they matched to the engines torque curve?
 - Why where the number of useable track gears selected (3spd box –vs- 6spd box)?

Example Gear Chart

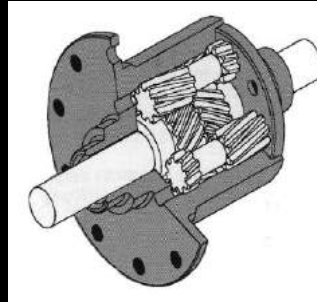
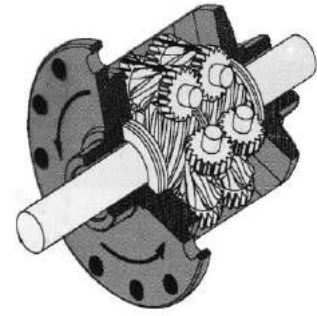


Example Tractive Effort Plot



Differential

- Differential Selection:
 - How does the differential selection support the cars objectives?
- Tuning Selection
 - If tunable, how was the initial differential tuning selected?



Handling and Integration

- How has the suspension and differential been tuned together?
- How have the off throttle corner entry characteristics been tuned?
 - Spring/Bar Package
 - Damper Package
- How have the on throttle corner exit characteristics been tuned?
 - Spring/Bar Package
 - Damper Package
- Is the differential tuned for different events/courses/drivers?





Questions?



Dwight Woodbridge

FSAE Design Judge Insight

- As a judge – what I am looking for, what am I not looking for, how I score

What are judges looking for:

- Fundamental understanding of the subject matter
- Good communication of design ideas
- Proper use of engineering theory, tools, resources to design, built, develop & validate your concept
- Demonstration of why design idea or concept is part of the submission & why it will work in competition
 - Theory / Test Results / Confirmation
- Unique / creative ways of measuring design
- Effective time management
 - Design effectively implemented on vehicle

What judges are NOT looking for

- Poor or lack of understanding of design or concepts on car submitted for review
 - *"a great design will not get points if the student team does not know why it is great" - or how/why it works*
- Inability to present the design to judges
 - Inappropriate student providing design review
 - Ineffective ability to communicate or lack of understanding of the design being presented.
- Presentation of a great design concept **not** brought to competition.
 - Demonstrates lack of program management
 - Judges can't award points for items not on the car

Examples

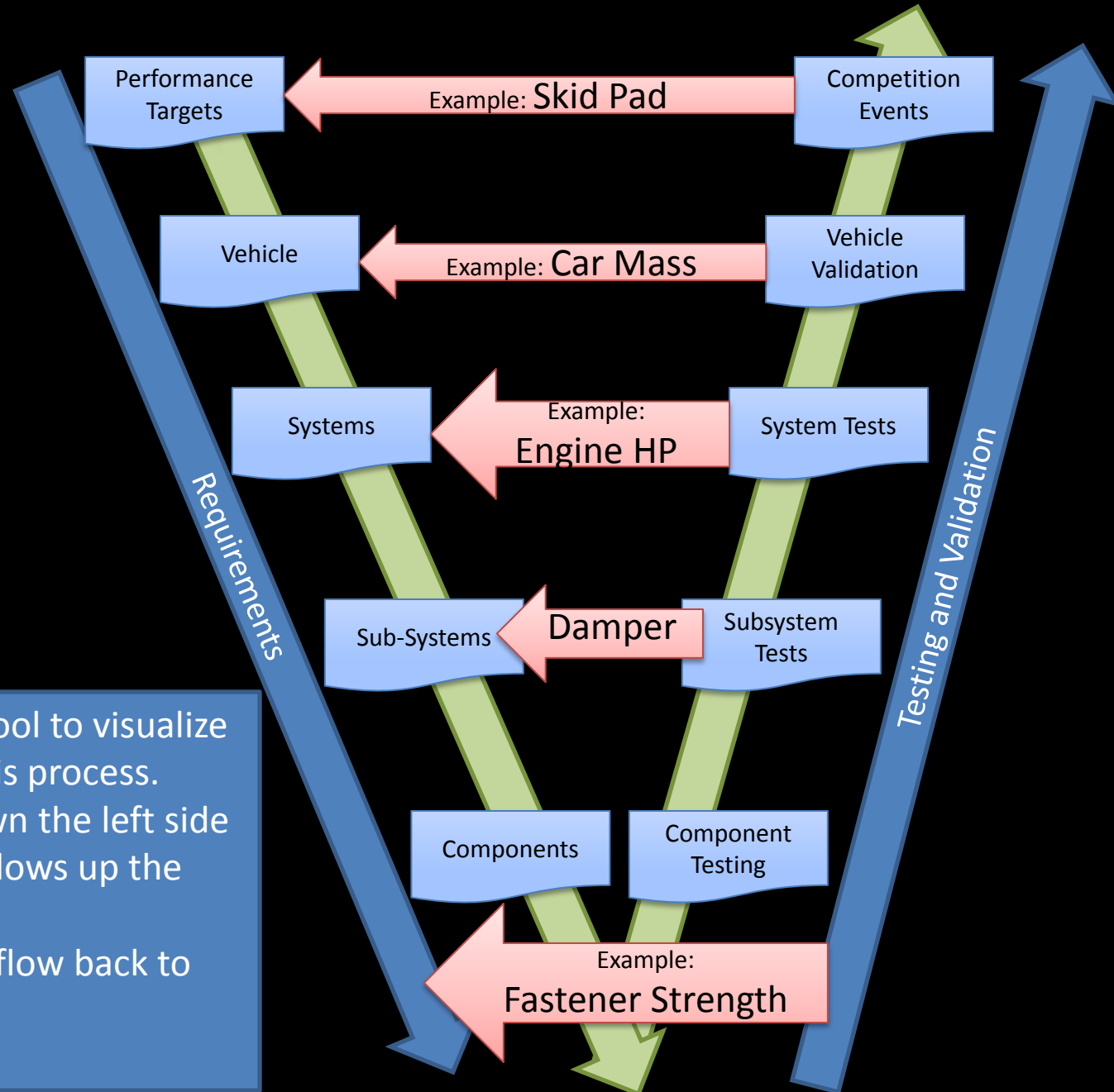
- 👍 Concept implemented on car that demonstrates a lap time improvement via theory (CFD / LapSim), testing (Wind Tunnel / skid pad) and the student can fully explain the concepts and details behind the submission
- 👎 Great concept implemented on car that former team developed and the presenting student(s) can not explain the theory behind the idea or does not have the fundamental understanding of the theory / concept
- 👎 Incomplete design, poor execution, poor validation

Tri Gaffney



Systems Design Theory

V-Chart

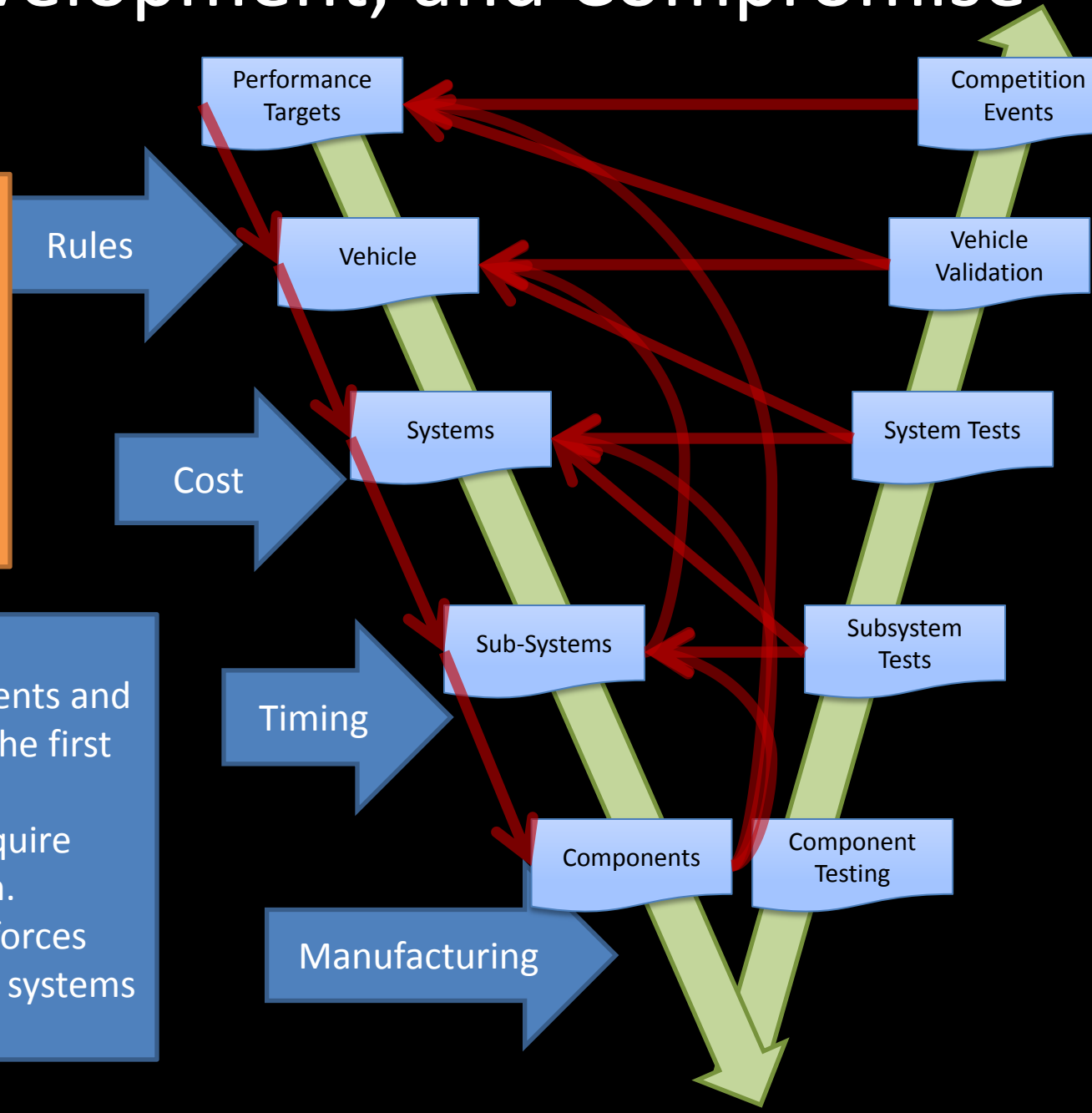


- The V-Chart is a good tool to visualize the design and synthesis process.
- Requirements flow down the left side
- Testing and validation flows up the right side.
- Metrics/Measurements flow back to their equivalent level.

Iteration, Development, and Compromise

Teams that can manage this process to develop a balanced car as a system **WITHIN** their cost/time constraints will be successful!

- Rarely does a design team synthesize their requirements and design the part correctly the first time.
- Other influences often require significant design iteration.
- Testing in one area often forces development of the other systems to occur.



Questions to Ask:

- What are my vehicle goals?
- What are my design goals?
- How does my sub-system support these goals?
- How does my sub-system integrate with other systems on the car to meet the goals?

Design Event

- Explaining your designs:
 - Make sure your supporting data is in books and having it laid out
 - Taking judges through the design process from objectives through development data.
 - Explain how your sub-system supports the overall vehicle objectives.
- What's important about the way the car looks in design:
 - Clean and prepared
 - Wires need to be tied properly, etc.
 - Have the tools to take body panels off during interview

Questions to Ask Yourself and your Team?

- Did I use a design tool or technology because it made the car faster or because I thought the tool/technology was cool?
- Are all my sub-systems balanced?
(Are there a super cool carbon re-inforced titanium widget one end of the car and tractor bolts on the other?)
- Did the team Iterate the designs together? -
OR- Where they done at the last minute?



Questions?

Thanks!



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