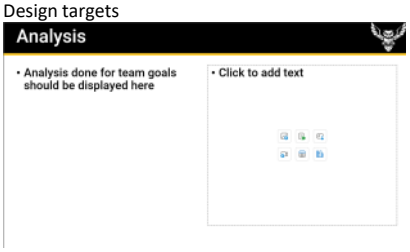
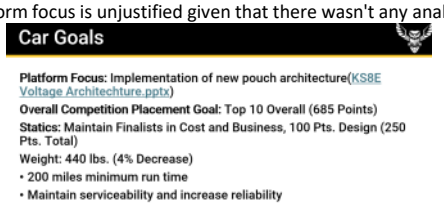
KS8 Team and Car Goal Debrief

Tuesday, July 22, 2025 6:13 PM

Issues from the goals last year: (All references are made from the KS8 Master Car Architecture Document linked HERE

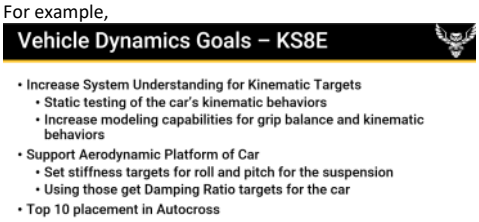
- Top level goals were not well justified or thought through
  - Design targets
  - 

  - I don't need to note anything this is just bad
- Platform focus is unjustified given that there wasn't any analysis from the competition results.
  - 

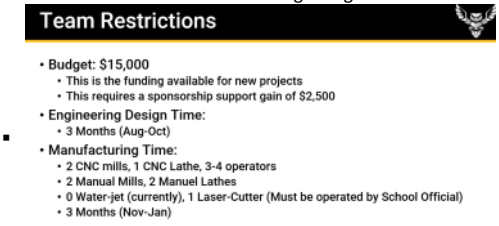
  - I think we start talking about maintaining finalists and maintaining weight but those seems like the steps to a plan that isn't talked about enough
    - By that I mean that if you are maintaining cost and business finalists need to know why you are doing that, prob because you want to retain top 10 to a certain extent
- Discussion on resource restriction is simply stated and not seen as design constraint that define design limitations
  - Turning these into models that you can use to drive decisions
  - Logging how much your upper bound constraints you have

- Throughout this year, subgroup integration was a huge problem
    - Showed in the final weight of the car
    - Vehicle in some areas is unoptimized
    - Lot of problems with collisions throughout the year
  - Root cause:
    - Separating design proposals across the week and by subgroup meant not as many eyes were able to view mechanical designs on the car
      - Shown in that weekly CAD Spins aided integration and getting design leads on the same page
    - From the top level, the goals were structured in a way where integrating pouch architecture was an overall car goals which isn't very actionable for a lot of teams
    - The top end of the goals structure needs to be better created

- Unactionable goals, hopeful subgroup goals
  - In the design for previous cars a lot of target values were set for things that didn't have a real path forward
    - The KS6 and KS7 both had goals for horsepower and overall vehicle weight which in it of itself aren't bad, they just aren't actionable
    - Likewise with lateral friction and Cl, these are all goals that exist and informed by point mass simulation but no concepts exist for whatever possible targets

- Designing in a bubble - Goals specific
  - Every subgroups goals are different in that nothing seems to be working for the car it's more of the subgroup
  - For example,
  - 

  - I'm sure that goals like system understanding was increased for a good reason, it just needs to be able to tie back to a larger car goal

- Designing and understanding team and development constraints:
  - Team constraints were stated at the beginning of the slide
  - 

- I think that stating these are a fine start to actually understanding what you work towards but there has to be a further breakdown after this as to how you make engineering decisions based on these constraints of the team
    - I think you also put yourself, if you define these well enough and their impact on performance, as to how much you can increase them realistically and have goals for funding and your manufacturing sub teams

2025 EV Points Analysis

Monday, July 14, 2025 12:50 AM

FSAE EV 2025 RESULTS.xlsx

From <https://kennesawedu.sharepoint.com/sites/Team-KS6-C/_layouts/15/sharedialog.aspx?crossdomain=true&migratedhosting=true&clientId=excel&clickTime=1752468635965&sharingCorrelationId=69FA9596-CD30-4CCB-A852-BFA81979806F>

KSU	2025 Scores	Cost	Buisness	Design	Accel	Skid	AutoX	Enduro	Efficiency	Total	Dynamic	Statics
	Percentiles	86.0	18.4	75						179.4	0	179.4
	70th	73.5	48.7	100.0	73.5	56.7	111.7	131.3	71.4	666.7	444.5	222.2
	80th	77.7	56.9	107.0	81.3	64.2	114.7	166.2	74.0	742.0	500.3	241.6
	90th	83.4	64.6	120.0	96.1	73.8	121.7	200.3	86.6	846.5	578.5	268.0

Time Percentiles (s)		
70th	4.17536	5.2376946
80th	4.06392	5.1068152
90th	3.86986	4.9513725
Acceleration Percentiles (Gs)		
70th	0.87707	1.32024
80th	0.92583	1.3887784
90th	1.02101	1.4773454

KSU	2024 Scores	Cost	Buisness	Design	Accel	Skid	AutoX	Enduro	Efficiency	Total	Dynamic	Statics	
	Percentiles	96.9	75	85	26.7	34.3	102.6	92.1	56.3	568.7	312	256.9	
	70th	75.1	51.1	85.0	51.2	49.8	102.5	235.5	53.7	704.0	492.8	211.2	7th
	80th	77.2	58.8	101.0	53.0	52.1	104.8	255.2	59.4	761.5	524.5	237.0	1st
	90th	82.0	65.8	125.0	64.5	61.1	111.0	261.0	75.1	845.4	572.7	272.8	1st

KSU	2023 Scores		Accel	Skidpad	AutoX	Enduro	Efficiency
	Percentiles	70th	65.6	43.7	91.3	216.4	92.45
		80th	72.2	44.8	106.0	239.0	93.3
		90th	94.8	59.9	108.6	271.8	97.95

Notes comparing percentiles:

- Accel was a larger make or break this year, while Skidpad and autocross took a hit
- Enduro was also a bigger deal last year in terms of percentile
    - *2024 had 20 teams finish endurance, this year had 10
- Efficiency is becoming more of a factor
- Statics stayed relatively close to each other

Event Score and Performance Targets

Saturday, July 26, 2025 11:54 AM

KSU	2025 Scores	Cost	Buisness	Design	Accel	Skid	AutoX	Enduro	Efficiency	Total	Dynamic	Statics
	Percentiles	86.0	18.4	75						179.4	0	179.4
	70th	73.5	48.7	100.0	73.5	56.7	111.7	131.3	71.4	666.7	444.5	222.2
	80th	77.7	56.9	107.0	81.3	64.2	114.7	166.2	74.0	742.0	500.3	241.6
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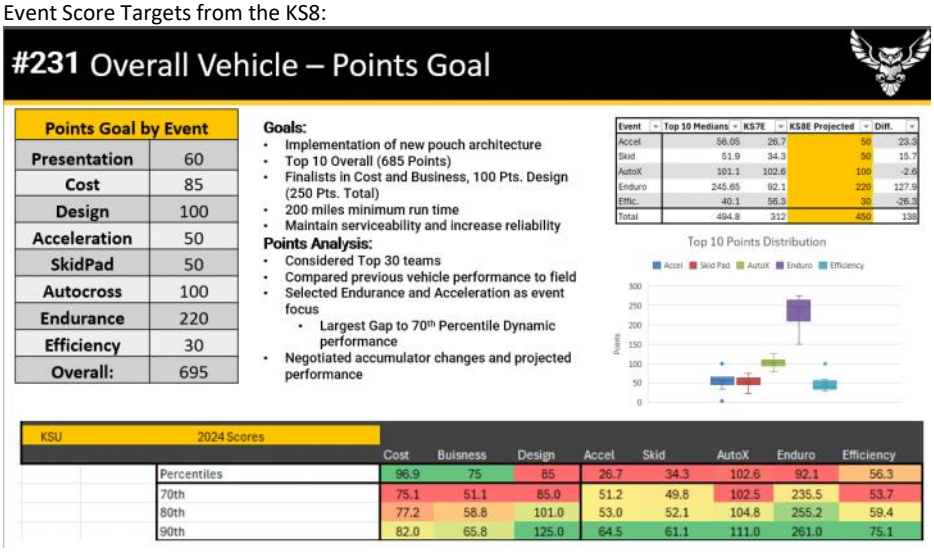
70th Percentile Performance:

- Cost: 73.5
- Business: 48.7
- Design: 100
- Accel: 73.5
- Skidpad: 56.7
- Autocross: 111.7
- Endurance: 131.3
- Efficiency: 71.4

Event Score Targets from the KS8:



Using Past 3 competition data, Points Targets for Each event (Average of 70th Percentile):

- Accel: 63.4
- Skidpad: 50.1
- Autocross: 101.8
- Endurance + Efficiency: 266.9
- Cost: 74.3
- Business: 49.9
- Design: 95
- Total: 701.4

Performance of Target Kennesaw Motorsports in Different Competition Years:

- 2023: 6th Overall
- 2024: 7th Overall
- 2025: 8th Overall

Performance windows for each event:

	2023	2023	2024	2024	2025	2025
	65th	75th	65th	75th	65th	75th
Acceleration	63	68	48	52	70	76
Skidpad	42	44.6	47	51	55	61

Autocross	91.1	98.4	101	104	109	113
Enduro + Efficiency	208.2	226	286	303	191	222
Business	53	58	50	56	44	53
Cost	73.4	78	75	77	73	75
Design	80	90	85	94	95	103
Total	610	663	692	737	637	704

KS9 Performance Windows:

Event	**Lower Bound**	**Upper Bound**
Acceleration	60	65
Skidpad	48	52
Autocross	100	105
Enduro + Efficiency	228	250
Business	49	56
Cost	74	77
Design	87	96
Total	646	701

Bounds defined by averages from the points of each event

Previously what was set were strict targets as just single values, not very often in testing will designs be as binary as hitting a threshold for a certain target. Does not capture the trade-offs design decisions typically are.

Dynamics Performance Targets

Sunday, July 27, 2025 4:40 PM

Equivalent scores in lap time and accelerations for accel and Skidpad:

Business	Design	Accel	Skid	AutoX	Enduro
18.4	75				
48.7	100.0	73.5	56.7	111.7	131.3
56.9	107.0	81.3	64.2	114.7	166.2
64.6	120.0	96.1	73.8	121.7	200.3

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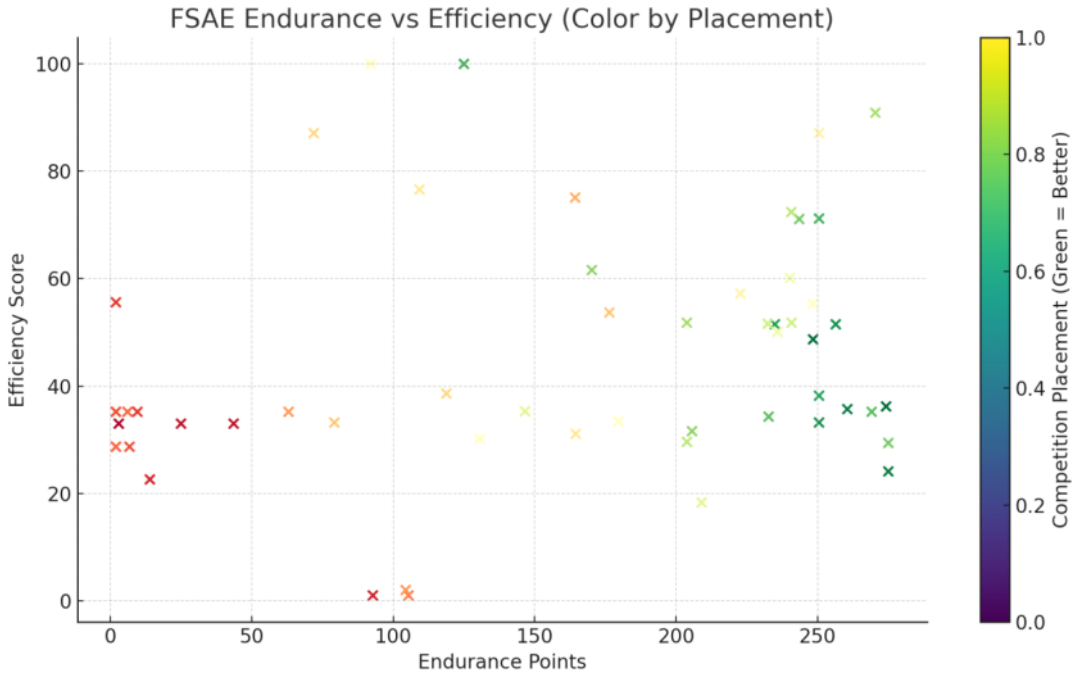
- Acceleration time achieved in east parking lot:
  - 4.669
    - Aero in Low drag
    - Tire pressures set
    - SOC unknown
- Expected from Simulation: 4.18
  - Using Matthews accel python script
- Notes:
  - Optimal Final Drive not put on the car
    - Even with the current final drive, 4.259
  - Does not account for tire forces for the current tire

Using Past 3 competition data, Points Targets for Each event (Average of 70th Percentile):

- Accel: 63.4
- Skidpad: 50.1
- Autocross: 101.8
- Endurance + Efficiency: 266.9

Endurance and efficiency are lumped because statistically, there is an inverse relationship between performance in endurance performance and efficiency performance for teams across all three previous competitions



Although the general trend for higher finishing teams is to do average in efficiency and do great in endurance, high placing teams have employed different strategies

The goal is to create a target to satisfy this minimum across both events for points to be earned, while also not being too restrictive and constrained in a design criteria from a top level, hence why these are combined into one category

Dynamic Performance Targets for Vehicle:

Event	Variable	Target	Unit	Notes
Accel	Accel Time	4.14 - 4.22	seconds	Taken from Points Target
Accel	Longitudinal Acceleration	0.85 - 0.89	G	Body acceleration - point mass
Skidpad	Skidpad Time	5.16 - 5.27	seconds	Taken from Points Target
Skidpad	Lateral Acceleration	1.30 - 1.36	G	Body acceleration - point mass
Autocross	Acceleration @ 9m Corner		G	Approx. Target Velo -> v^2/r
	Acceleration @ 18m Corner		G	
	Acceleration @ 41m Corner		G	

Acceleration

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Time for the KS8 Actual is taken in East Parking Lot

- SOC for the car at the time is unknown nor the torque and power commanded from the Inverter
    - Can check the Foxglove of 06/11 test day

Tasking - Simulation:

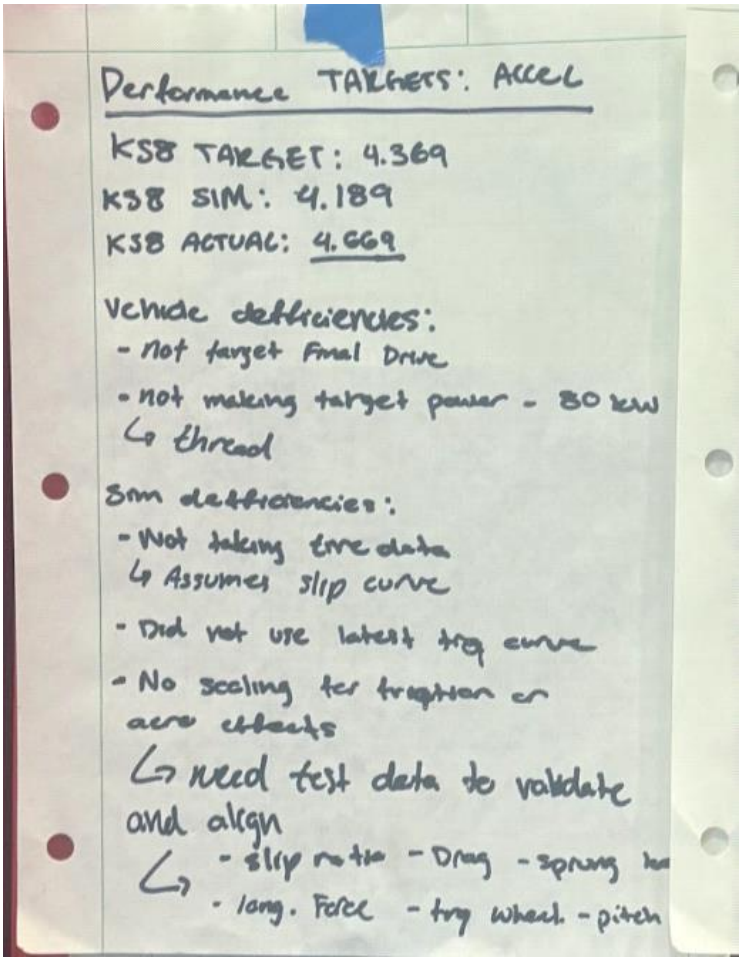
- Rerun the simulation with current dyno plot of the KS8E
- Check with current setup for vehicle final drive if car is still suffering in accel time

Tasking - Testing:

- Sensors on the car necessary to relate back info
    - Wheel speeds for front and rear
    - Inverter commanded torque
    - Load cell / shock pot
        - Load at the tire

Rationale:

- At launch we can neglect drag effects of the aero, when reading load cell data you can get instant loading of the rear axle
- With launch of the car can get approximate longitudinal mu of the tire
- Wheel speed F/R can give slip ratio, relate back approximate force at the tires



Skidpad

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Notes about the time actual for KS8:

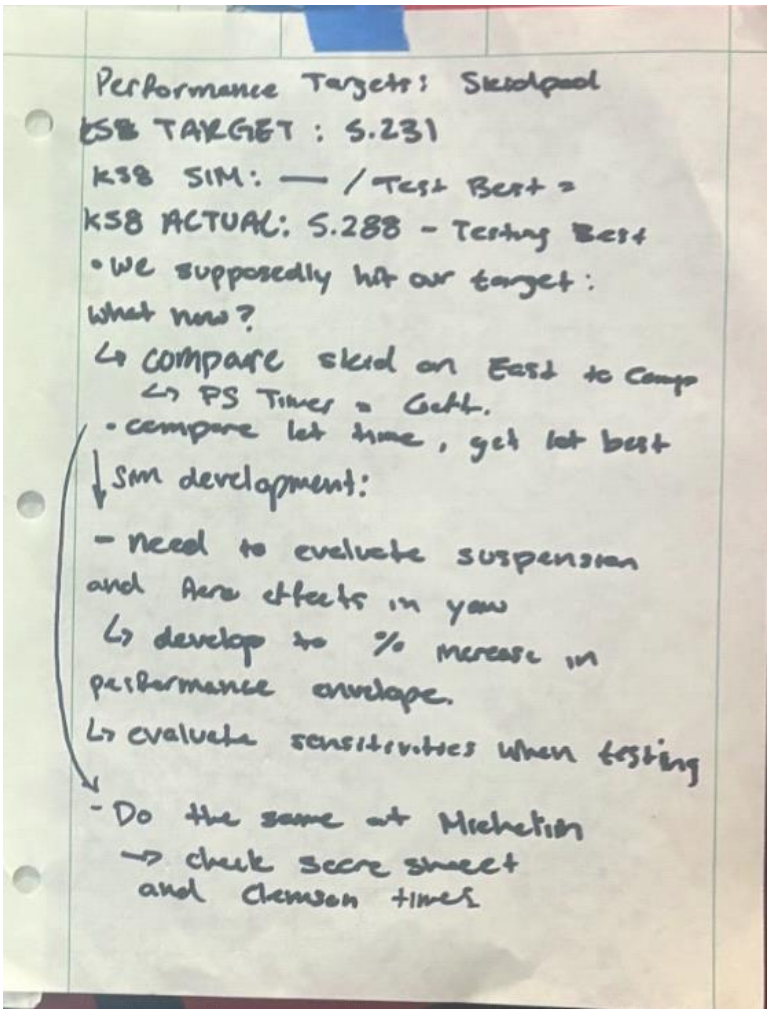
- Taken at east parking lot
- Was done after continuous runs of Skidpad at night
- Conclusion, car could be capable of target time in Skid pad, much more testing time on a flatter / more controlled parking lot necessary
- No chassis or aero tuning done to the car

Tasking - Simulation:

- Re open the four wheel model for Skidpad
  - Based on 4 term Pacejka model
- Main focus should be getting aero and suspension parameters and evaluate at steady state

Tasking - Testing:

- Re-evaluate Skidpad times across different drivers in the car
- Getting coefficients from when we ran Skidpad at Formula South in East Lot and compare them to the respective cars at Michigan
  - Can extend this data to the KS7 and KS6



Autocross

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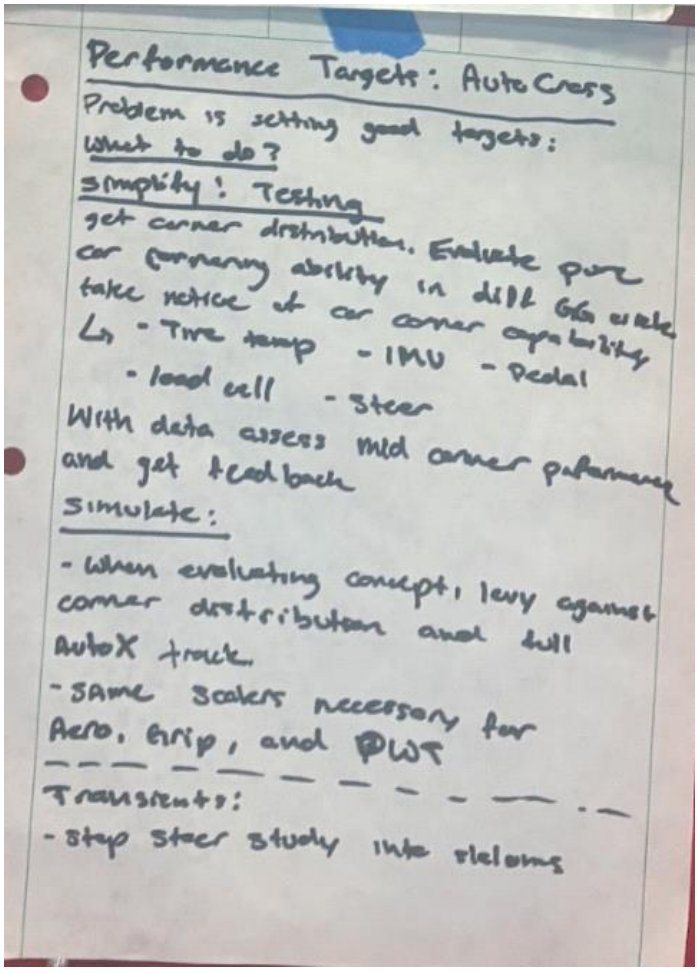


Notes about Autocross for KS8:

- Did not get a lot of testing in the KS8 for autocross
- Need to break down autocross into specific deliverable maneuvers

Breaking down autocross:

- Corner radii SS
  - Based on the distribution of constant radius corners at competition
- Slaloms SS
  - Distribution of slalom length
  - Although inherently transient, given the change in direction, it can be simulated as a sinusoidal wave going through cones
  - Acceleration is constant, you solve for velocity given the amplitude and wavelength

Transient Simulation:

- If you have the steady start parts of the car simulated and fully tested can move to transient maneuvers
- ISO Maneuvers for Vehicle Dynamics describe steps like step steer for evaluating control and stability, that describes multiple maneuvers the car sees on track

Tasking - Simulation:

- Rehash the previously referenced steady state Skidpad model

2025 Michigan ...

Conclusions from Corner Radius Distribution Study:

After filtering out the slaloms which would skew the data to very small radius corners, distribution for corners are as follows

Median Radius (ft)	% of Corner Makeup
29.2	52.8
58.6	36.4
133.3	10.8

Kinda scuffed way of deriving vehicle targets in Skidpad,

$v^2/r = a_y$

$F_y = m * a_y$

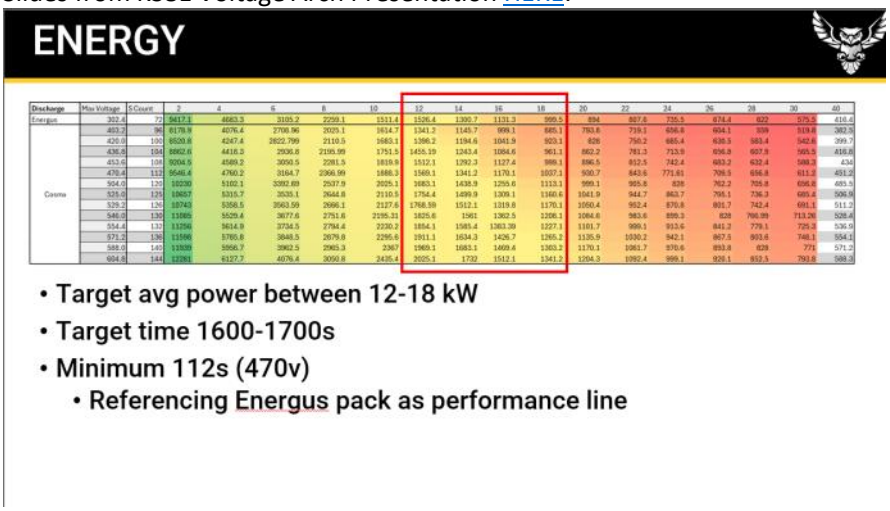
$F_y = mu * (W+DF)$

$a_y = (mu * (W + DF))/m$

Endurance + Efficiency

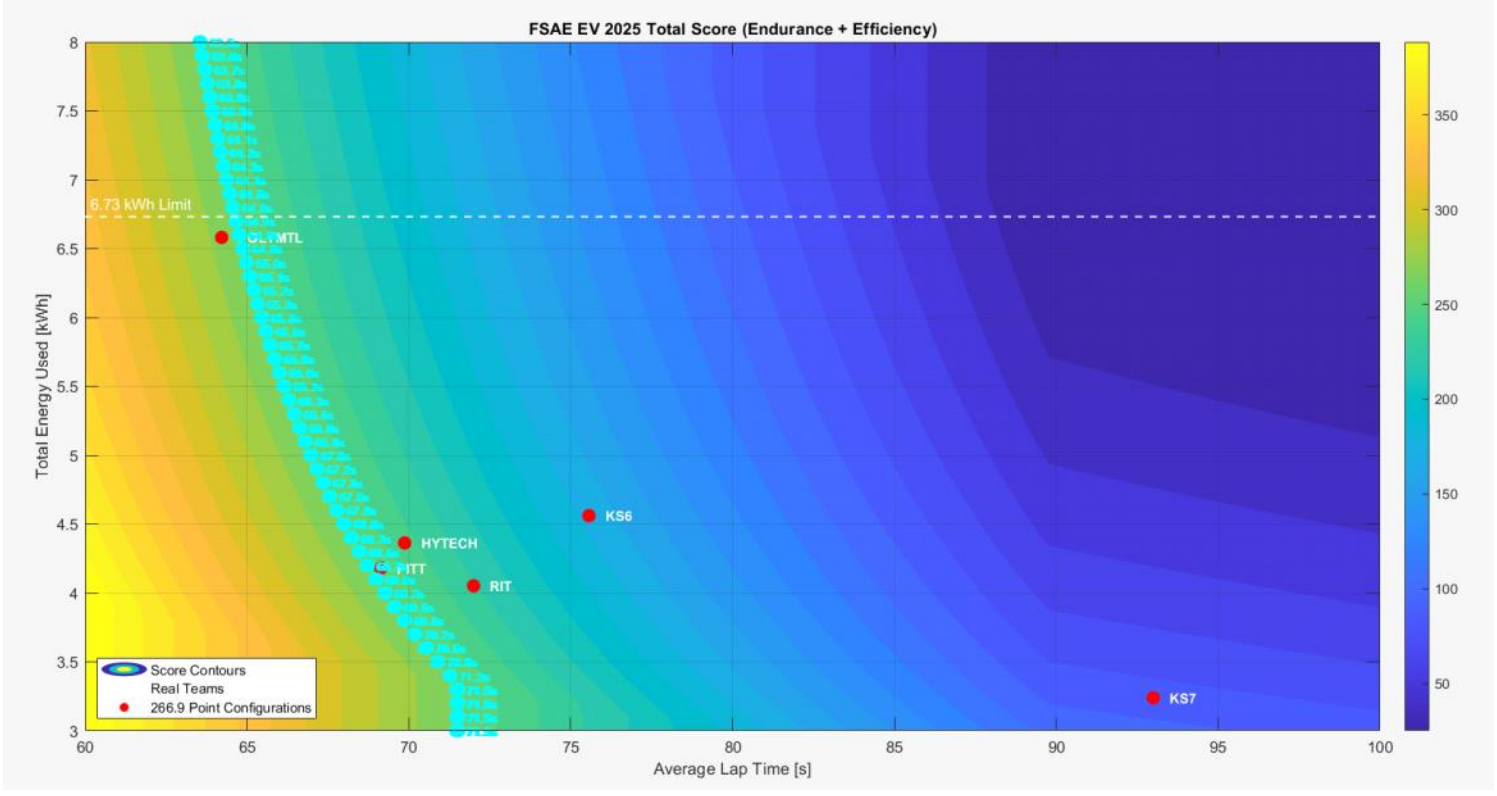
Monday, July 28, 2025 11:56 AM

Slides from KS8E Voltage Arch Presentation HERE:



Score Assessments from Previous Competitions:

Year	T_Min	Efactor_Max
2025	1369.936	0.848
2024	1581.258	0.845
2023	1488.683	0.841
Average	1519.767	0.845



- 6.73 kWh Limit set from accumulator architecture for KS8E
- All scores / benchmark teams are +/- 5 points from actual scoring

- Light blue dots represents possible configurations to achieve 267 point target for both events

Given

Statics Performance Targets

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Vehicle Concepts

Monday, August 11, 2025 10:01 PM

Concept	Weight (lbs.)
470V - No Aero	410
588V - No Aero	440
470V - W Aero	452
588V - W Aero	480

*Concepts derived from given Vehicle and Resource Constraints

Concept	Acceleration	Skidpad	Autocross	Endurance	Efficiency
470V - No Aero*	4.28s	5.27s	59.51s	79.25s	0.60kWh
588V - No Aero*	4.23s	5.23s	59.72s	79.01s	0.63kWh
470V - W Aero*	4.46s	5.14s	56.11s	77.28s	0.66kWh
588V - W Aero*	4.41s	5.10s	55.97s	77.21s	0.69kWh
KS7E	4.69s	5.22s	56.04s	85.63s	0.32kWh

Mass Distribution of KS8E

Chassis	65
Suspension	101.8
Cockpit	14.839
Safety	18.23
Powertrain	186.536
Aero	41.722
Driveline	27.863
Low Voltage	9.416
Misc	15
Total	480

Mass of 470V No Aero

Chassis	65
Suspension	101.8
Cockpit	14.839
Safety	18.23
Powertrain	156
Aero	0
Driveline	27.863
Low Voltage	9.416
Misc	15
Total	410

Aero Values - No Aero

Parameter	Value
Frontal Area	0.626 m^2
Drag Coefficient	0.280
Lift Coefficient	-0.003

Target for Autocross - 48.5 seconds
KS7E Achieved in 2024 - 49.689 seconds
With a 30kW max, like it had at competition, the KS7E has an autoX time of 55.37s in the sim

Translates to, 49.689/55.37 = 0.8974 as a pseudo correlation value for all the simulation lap times

With the weight estimate from the SRR, as well as borrowing aero coefficients from the previous seasons, the KS9E in autocross achieves a raw lap time of

——Vehicle and Resource Constraints——

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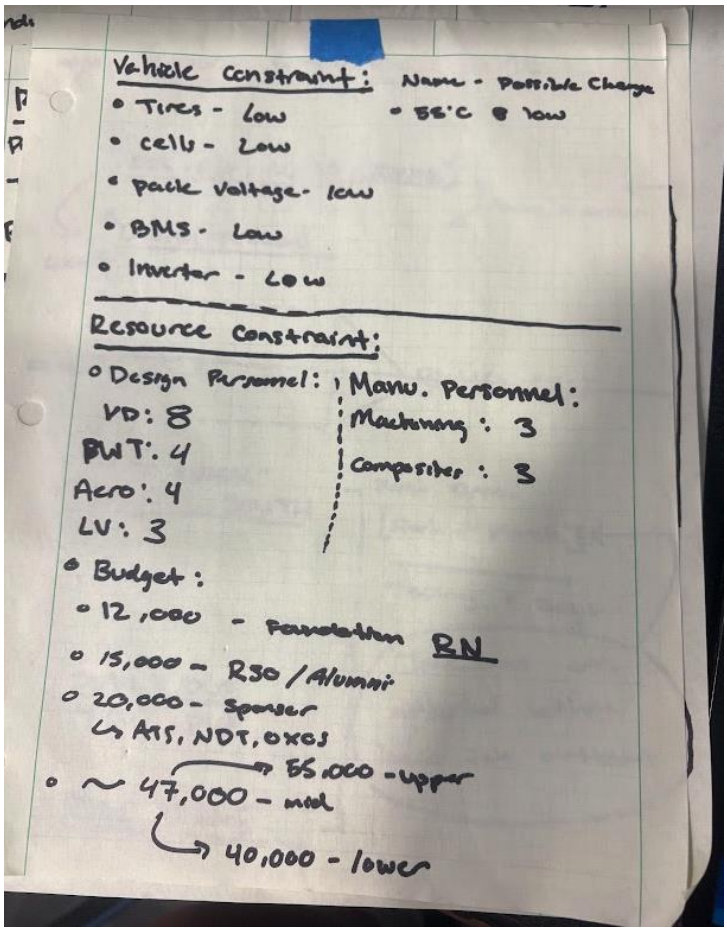
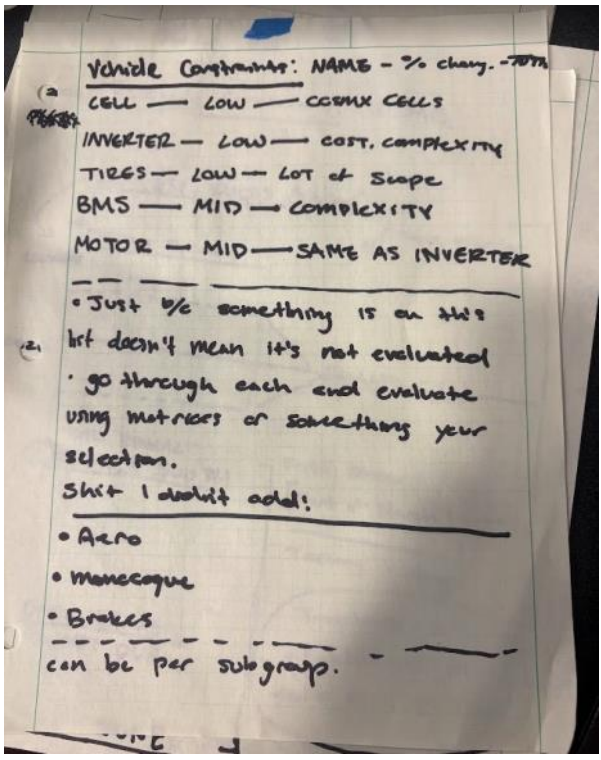


Vehicle Constraints

Monday, July 28, 2025 2:42 PM



Vehicle Constraints - Spreadsheet

Constraint	Level	Value	Justification			
Accumulator Voltage	Fixed	140s1p 588V	Vehicle Scope and Cost			
Motor and Inverter	Fixed					

Vehicle constraints defined as:

- Vehicle design decisions that are fixed due to mainly resource constraints or technical constraints in budget, personnel, development, etc.

Resource Constraints

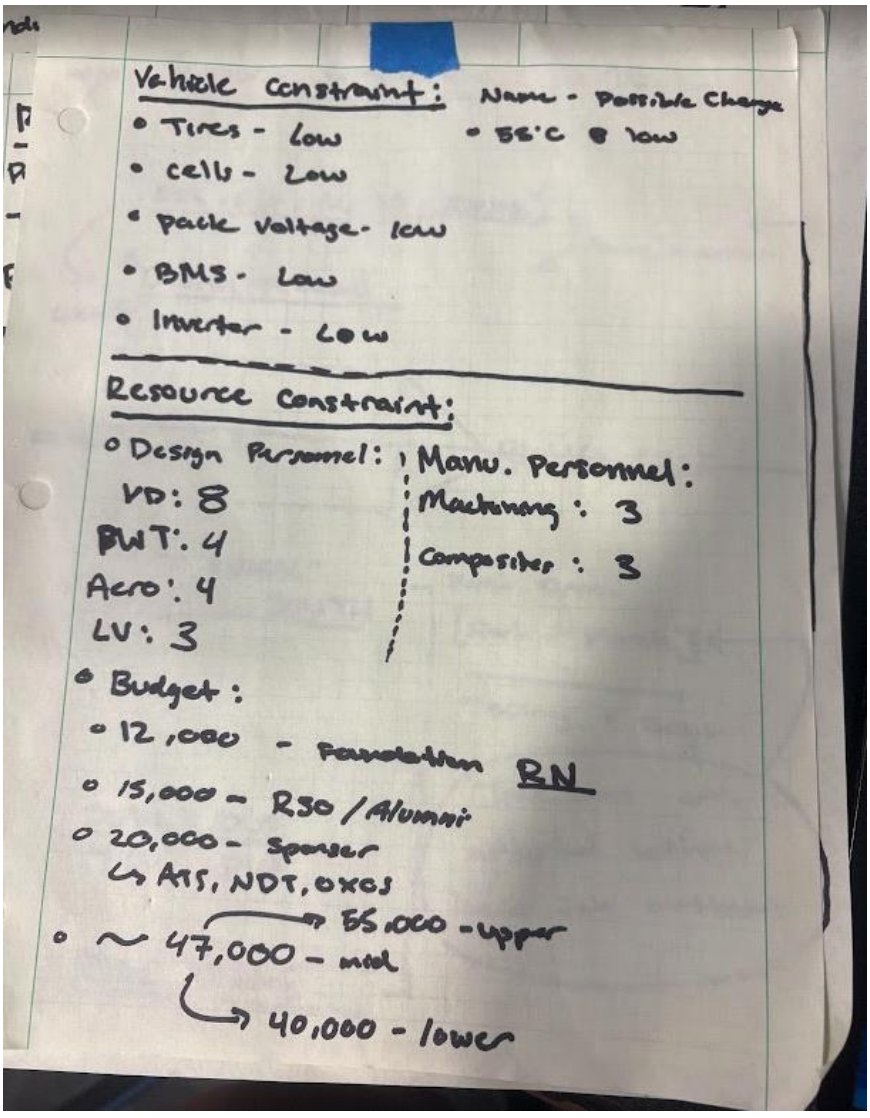
Monday, July 28, 2025 2:42 PM

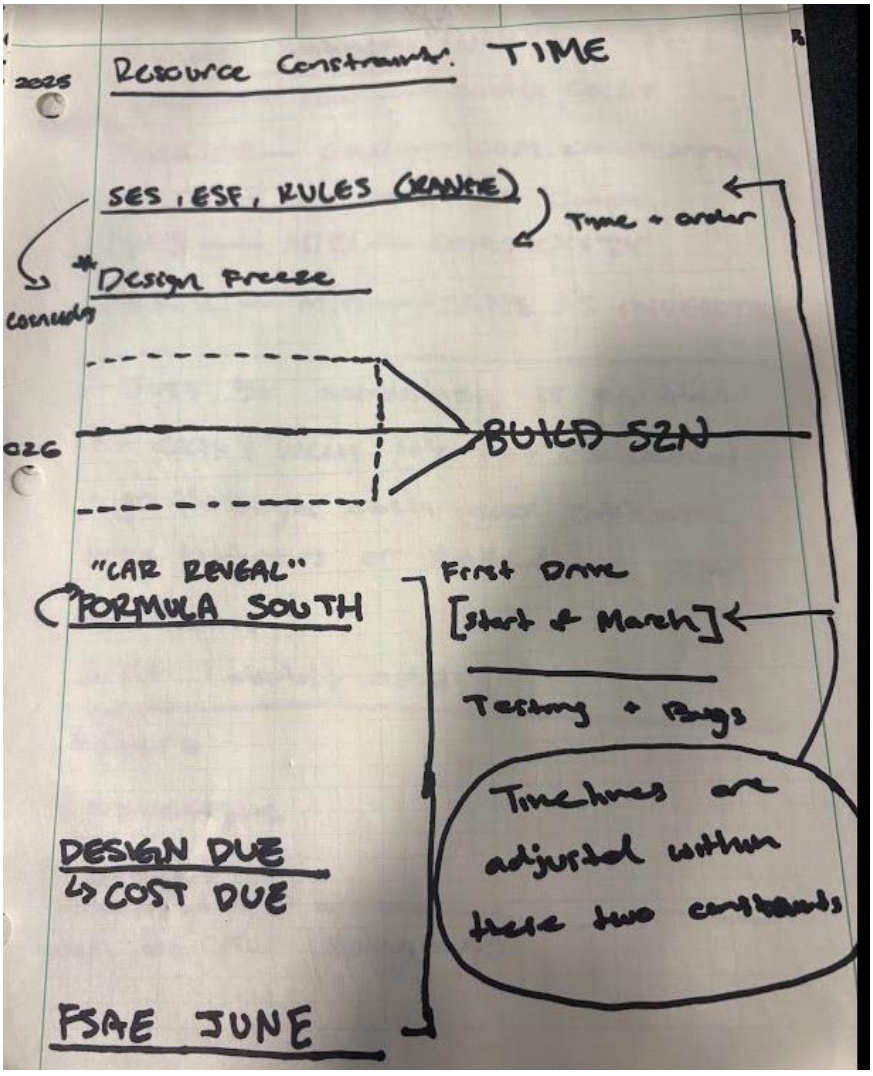
Main Resource Constraints for the Team:

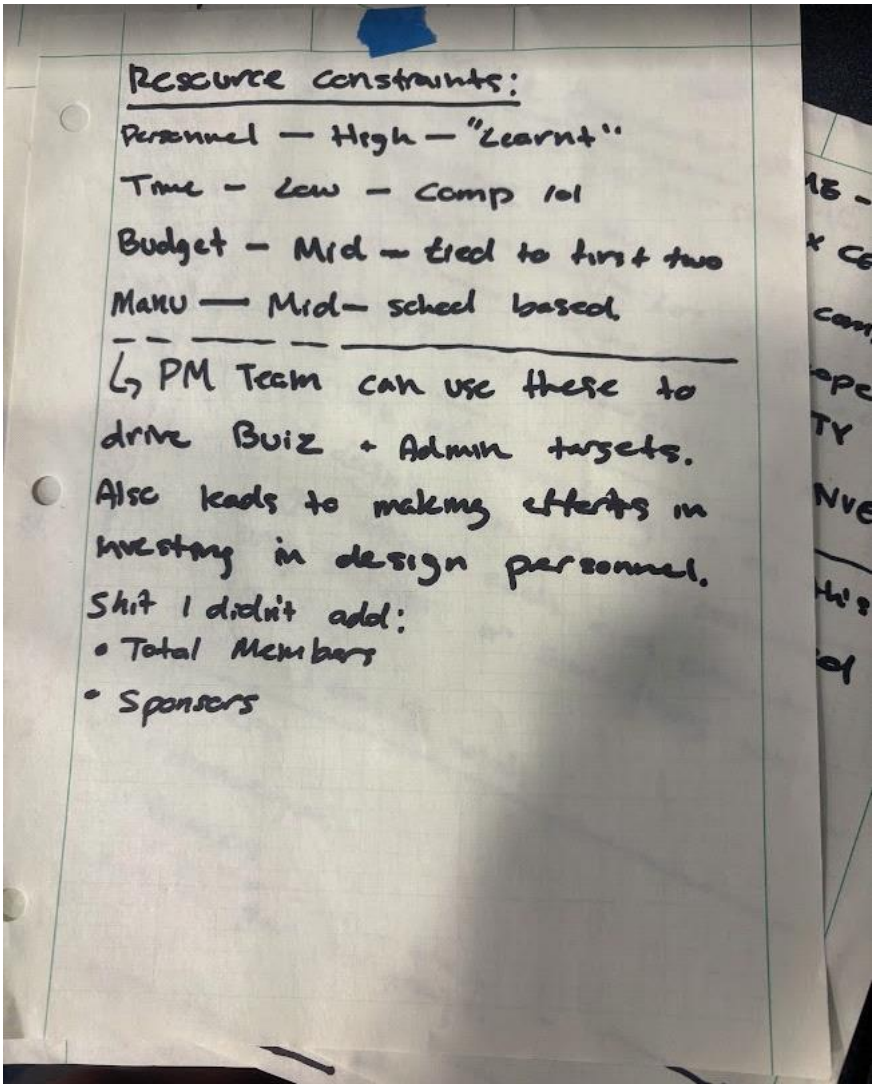
- Time
- Money
- People

Time:

- We need the car competition ready at least by June Competition
- To hit our performance targets and continue development need time for the car to drive and test
- Bounds for time defined by the time the rules of the competition are done




2025
Resource Constraints: TIME
SES, ESF, RULES (FRAME)
Time + order
* Design Freeze
controls
026
BUILD SZN
"CAR REVEAL"
FORMULA SOUTH
First Drive
[start of March]
Testing + Bugs
Timelines are adjusted within these two constraints
DESIGN DUE
↳ COST DUE
FSAE JUNE


Resource constraints:
Personnel — High — "Learnt"
Time - Low - Comp lol
Budget - Mid — tied to first two
Manu — Mid— school based
↳ PM Team can use these to drive Buiz + Admin targets.
Also leads to making efforts in investing in design personnel.
Shit I didn't add:
• Total Members
• Sponsors

——Design Meeting Notes——

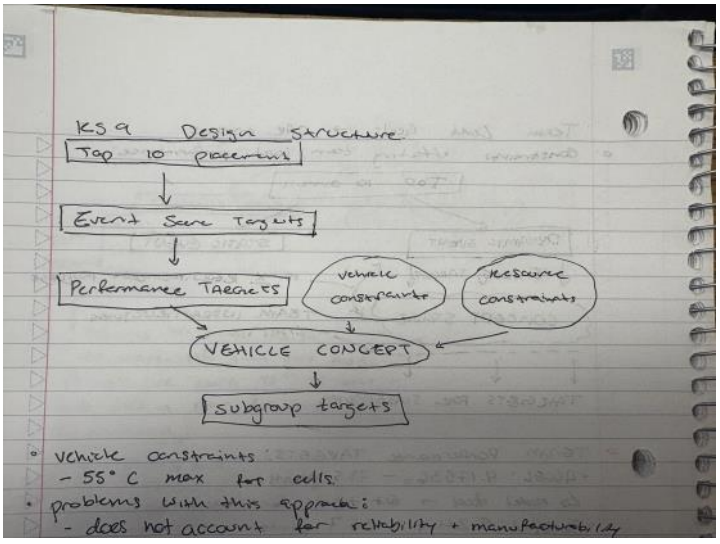
Wednesday, July 23, 2025 3:08 PM

07/23/2025 Design General

Wednesday, July 23, 2025 3:08 PM

- Lessons learned of design from top level of KS8
  - Team Goals
  - Car Goals
- How we can improve
  - Constraints Matrices (Infrastructure and Vehicle)
    - What stuff can't change
    - What stuff can change within team level
  - Top Level Goal structure
    - Points analysis
    - Testing plan to arrive at design targets
  - Design Meeting structure
    - Proposal System
      - Templates
      - Meetings and approval process
- What's needed for further development
  - Lap time simulation
    - OptimumDynamics
      - Schedule Demo
    - Need list for what necessary for lap time simulation
    - Energy modeling across endurance
  - Architectural changes
  - Infrastructure limitations
    - Manufacturing (composite + machining)
    - Funding
      - @Tyler and @Richard

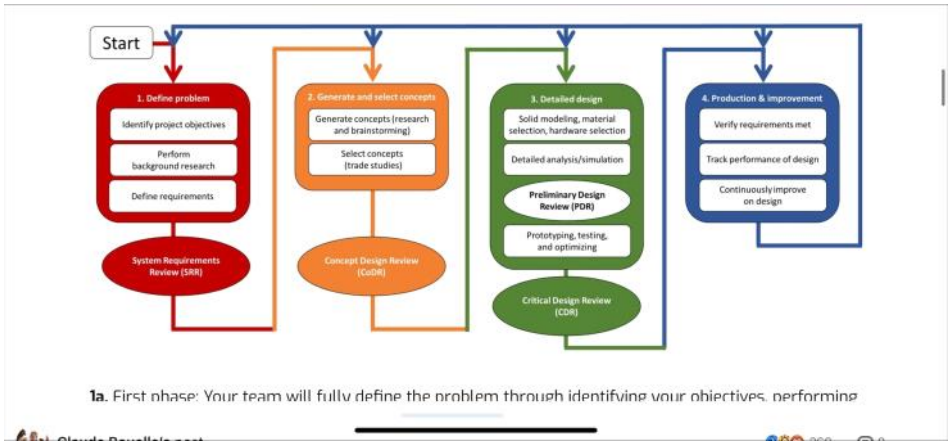
variable	value	level
Tire Selection	Lateral force	none
Pack Voltage	588V	low



Vehicle Constraints:

- Min Energy (kWh)
  - Energy at wheels
- Max Tire Force (lbf)
- Cell Temperature

- Mass + Weight
  - More so derived value less than a constraint



Resource Constraints:

- Design Personnel
- Manufacturing Personnel and Infrastructure
- Cost
- Time

Testing necessary for Design:

- Mock Endurance
  - Energy consumption and Cell temperature
- Skidpad and GG circle to measure pure car performance
  - Michelin testing
- Suspension travel
  - Damper velocities
- Aerodynamics
  - Pressure Tap Data
  - Coast down - Motor Stress
- Powertrain
  - AIRS Cycles
- Low Voltage

Project Proposal (Mechanical Feedback)

- Milestones and Task Tracking need to be removed
- Scaling for different projects in systems
- Reinvestigate time tracking for components as historical data
  - Want the time consumption data to be useful
    - Mainly at system level

Circuit Proposal Feedback

- Gantt chart and task tracking isn't effective and redundant

Proposal Reviews:

- Return to full team review meetings
- Project Proposal has to be reviewed by subgroup before continuing to full team review

07/28/2025 Design General

Friday, July 25, 2025 5:04 AM

From last year goals assessment:

Goal	Value	Reached
Integrate Pouch Cell Architecture	Yes	Yes - Didn't Race*
Top 10 Overall Placement	10	45
Weight Target	440	496
Minimum Miles of Run Time	200	25
Maintain Serviceability and Reliability*		

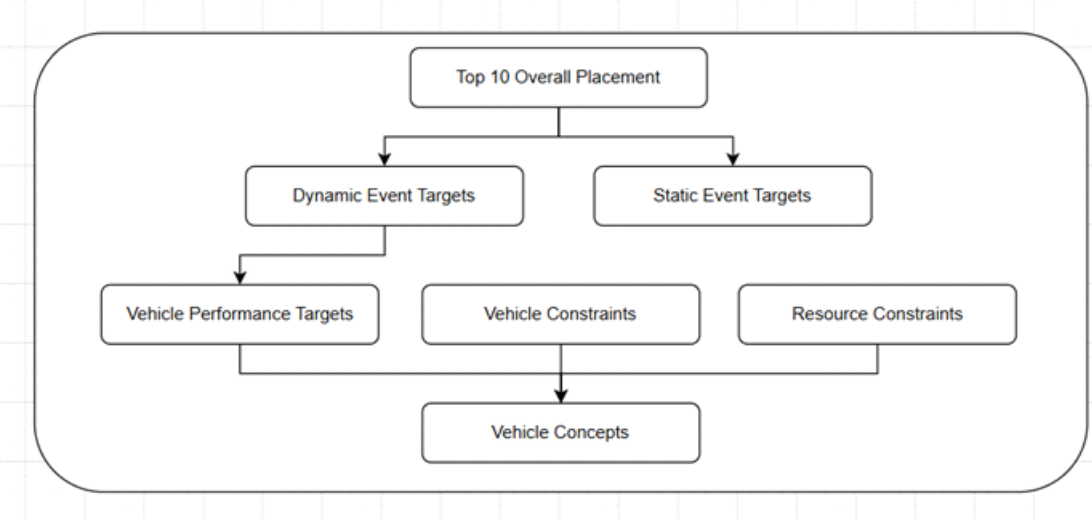
From KS8 Michigan Competition:

	Cost	Business	Design	Accel	Skid	AutoX	Enduro	Efficiency	Total	Dynamic
Percentiles	86.0	18.4	75						179.4	0
70th	73.5	48.7	100.0	73.5	56.7	111.7	131.3	71.4	666.7	444.5
80th	77.7	56.9	107.0	81.3	64.2	114.7	166.2	74.0	742.0	500.3
90th	83.4	64.6	120.0	96.1	73.8	121.7	200.3	86.6	846.5	578.5

- Car did not pass tech inspection
- Had tested barely up to that point

From KS9 Start of Year:

- High turnover in previous leadership
- Team increased in size from last year, have not experienced full design process



Vehicle Mass Target

Thursday, August 21, 2025 5:06 PM

Mass Distribution of KS8E

Chassis	65
Suspension	101.8
Cockpit	14.839
Safety	18.23
Powertrain	186.536
Aero	41.722
Driveline	27.863
Low Voltage	9.416
Misc	15
Total	480

	KS9 LOW	KS9 MID	KS9 HEAVY
Chassis	64	65	66
Suspension	100	101	102
Cockpit	12	15	16
Safety	18	18	19
Powertrain	180	185	187
Aero	40	42	43
Driveline	25	26	28
Low Voltage	9	9	9
Misc	15	15	15
Total	463	476	485

This was based on me literally scraping through all of the schizophrenic excel spreadsheets since the KS6, for future reference mass tracking throughout the design season and build to both line up our CAD accuracy but also simulation accuracy is going to be very integral.

One of the basic things a race car needs that defines it's performance as a block of physics is mass. Will go into later depth of how that is going to be tacked throughout the design season as well as what we want to tackle throughout the build season.

Vehicle Mass Tracking Sheet

Saturday, August 23, 2025 4:49 PM

The KS8E had many design changes made to it throughout the fall semester and none of it was ever consolidated or documented against each subgroup. Because of that the mass creeped up between the car before and after the design season going way out of our projection. Although no apparent components failed throughout this mass creep, fundamentally there will be a point where if an unaccounted for mass increase of the car happens, component design will have to propagate and everything on the car will have to be increased as a result

To combat this fundamental issue of the car and an attempt to control the mass to make wiser and more justified design decisions, mass tracking will be implemented incrementally throughout the design season so mass of the car does not run away with the development of the car

KM_Mass_Track.xlsx

From <https://kennesawedu.sharepoint.com/sites/Team-test_ksu/_layouts/15/sharedialog.aspx?listId=30633b31-2f3f-4c37-af1a-fee052f7f83c&clientId=sharePoint&sessionId=dbb0bea1-f09b-a000-039c-6e980e9fc29c&listItemId=2063&clickTime=1755986299999&sharingCorrelationId=59ea6e4a-034a-407f-9ea0-2890904c1ac6&mode=copy&ma=1&fullScreenMode=true&itemName=KM_Mass_Track.xlsx&channelId=ae8ca821-5593-4393-a915-54061b41f351&origin=https%3A%2F%2Fkennesawedu.sharepoint.com>

Vehicle Architecture Synth

Saturday, August 23, 2025 5:37 PM

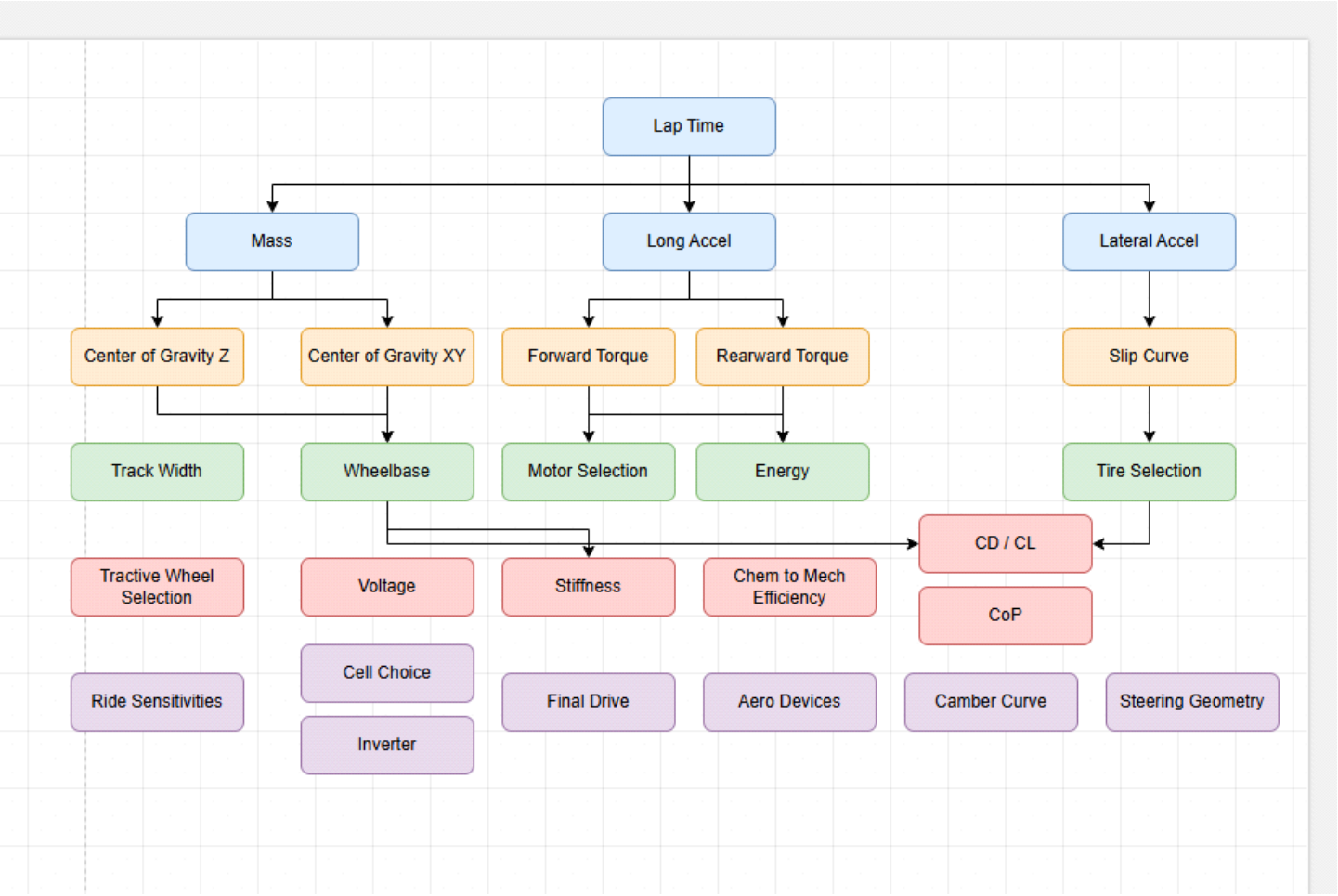
One night before Michelin testing, topic came up about how we were deriving lower level vehicle targets and how they were supposed to support the goals set for the overall vehicle and it's placement in competition so they don't contradict/ conflict with other vehicle goals.

Below is the flowchart made for that night, also included in the miscellaneous folder of the Vehicle Goals Teams
Vehicle-FlowChart.png

From <https://kennesawedu.sharepoint.com/sites/Team-test_ksu/_layouts/15/sharedialog.aspx?listId=30633b31-2f3f-4c37-af1a-fee052f7f83c&clientId=sharePoint&sessionId=dbb0bea1-f09b-a000-039c-6e980e9fc29c&listItemId=2064&clickTime=1755985304851&sharingCorrelationId=b60da827-04fb-4154-9ef4-ec6f007dbc54&mode=copy&ma=1&fullScreenMode=true&itemName=Vehicle-FlowChart.png&channelId=5e670a4b-1073-48e9-92c6-eb919077032f&origin=https%3A%2F%2Fkennesawedu.sharepoint.com>

Although there are a couple of questionable placements for some of these variables, the overarching vehicle priorities as well as the cascading decision making of the cars design overall holds true. The main reason is there are nearly an infinite amount of solutions for possible vehicle designs at the upper levels of the flow chart

This is where defining both resource and vehicle constraints are going to be a very important thing to implement and see where that limits or improves other possible cascading design decisions. This is logic that also holds true in real world engineering application, sometimes designs overall have to cope with rigid design architectural constraints.



To stick to this sort of vehicle overall purview, some of the larger scope vehicle design parameters will be tracked throughout the design season to ensure that they are within an acceptable design range. These include:

- Mass
- Yaw inertia
- Center of Gravity Height

Although the positions of these variables vary across the flow chart, at the upper levels of the vehicle flow chart, there is no design variable that has as much of every subgroup involved with the decision as these three

Vehicle Mass Investigation

Saturday, August 23, 2025 6:00 PM

Yaw Inertia Investigation

Saturday, August 23, 2025 6:03 PM

CG Height Investigation

Saturday, August 23, 2025 6:03 PM