KS8 Development

Monday, July 15, 2024 7:22 PM

ergo brake steering projects

brakes
- rotor redesign
design work, a lot of sim shit maybe, have back up of solid rotors
- method of floating rotors - rotor mounting
easy af tbh, redesigning hubs anyway
- master cylinder investigation
realistically not buying new, design justification. can look into KS9 dev
-brake pad investigation

ergo
- pedal box mounting and pedal stiffness redesign
some work, can give to senior member
- seat investigation (inserts)
has experience with, should do more robustly
- steering wheel
easy af, depends on scope with LV @chance
- ergo rig
needs to remanufacture and some minor design changes. could be on KS8, prob KS9
-bias knob
Just spec it out for Sam and integrate into pedal box
-steering wheel placement

steer
- ujoint selection and sizing
medium amount of work, look into phasing, ackermann% investigation and would require jig for weld
- carbon steering column
calculate worst case torsional, needs splines manufactures for it and bond method nailed
- steering bushing/ bearing
generally just remanufacture bushing, could look into investigating if bearing is worthwhile
-steering stop width/minimum steering angle

general practice
- quick disconnect brake lines
- rebuy quick disconnect for steering
- above all resurface rotors
- measure steering column length on car
- rebuild master cylinders
-brake pedal return spring

Design Event 2025

Tuesday, November 19, 2024 9:13 PM

What is needed for design (testing, validation, etc.)

Ergo:
- Mocap lab scan of drivers in rolling chassis
- Driver Anthropometric data
- Elbow range in car? Find everyones preferred degrees of freedom.
- Ergo rig - need to build/measure drivers
- Seat Insert sample testing
- Seat deflection w/wout insert
- Driver movement in seat
- Pressure points inside cockpit - make questionnaire and record driver feedback throughout testing season
- Driver Seating Position Design Flowchart
- CG Migration Based on seating position
- Empirical visibility study

Brakes:
- Wilwood Purple vs bp-20 pad choice
  - Increased Ecar weight (WT Calcs)
  - Theoretical Deceleration with new vs old pads
  - Purple vs BP28 estimated mu testing
  - Full theoretical brake torque calcs with bp28 mu
  - Theoretical Input force vs weight transfer graph
  - Input force vs heat generated vs weight transfer
  - Brake temp sensors integration (ktype thermocouple in center of brake pad)
  - Heat Generation Testing
- Slotted rotor shit
  - FEA
  - Heat Generation - need to redo with new bp28
  - Ecar brake dyno ;)

Steering:
- Steering torque w/ torque wrench
- Steering effort vs weight transfer/lat accel -> prelim calcs done, need to validate once we get cars built.
- Measure max steering lock
- Measure ujoint angles and figure out if in phase
- Measure steering slop @ rack, wheel, upright, ujoints
- Steering Rack Weighed Decision Matrix

Controls:
- Pneumatic shifting tank sizing - math done, waiting on car to be done to validate
- Force at piston pneumatic shifting (wasim)
- Shift time measurement - Martin
- MS3 Wheelspeed LC
- ECAR Throttle Shape Testing
- Electric Shifting Component Selection/Design Matrix - Jordan
- Pedal Box Deflection Testing
- FIX PEDAL BOX CAD (I can do this if nobody else wants the extra cad practice)

Stuff that would be good for next year:
Brake Pedal Load Casing
Validating Steering Effort
Convective Heat Transfer Coefficient
Full Force/Shift for every single gear, possibly figure out how to do it while car is moving
Brake Temp sensors for more detailed validation
CG position vs Seating Position

Brakes

Tuesday, June 25, 2024 8:19 PM

Brakes Validation Plan

Tuesday, June 25, 2024 6:28 PM

Why?

We have lots of math done that I would like to attempt to validate through real world testing.
This includes things such as:

- Braking force
- Rotor temperature
- Deceleration force on the entire car
- Heat generation accounting for drag/rolling resistance

How can we validate our math?

- Deceleration force on the entire car:
  - Integrate a range of wheel speeds for a range of decelerations
  - If we have deceleration, then that could be plugged into F=ma, which would give us the braking force the front/rear experience from deceleration
    - ***Additionally,*** if we were to run this test repeatedly while removing components responsible for driveline loss/rolling resistance/drag, we could come up with a number for how much rolling resistance/drag affects our stopping capacity.
- Braking force
  - Divide those by 2 for a rough approximation of how much braking force we actually make (accounting for friction from tires) and compare to previous math.
- Rotor Temperature
  - If we can implement rotor temperature sensors into the DAQ system this year, we can run a test where we have a driver brings the car up to a consistent speed and brakes repeatedly with a consistent braking force (if consistent force is not possible on pedal, we can do it at varying forces and take an average pedal force).
  - Paired with the rest of the DAQ system, this would allow us to generate a graph with Rotor Temperature vs. Pedal Force per g of deceleration, which if rotor temperature was being constantly measured and logged, would give us a heat generation curve of our rotors (could also do average force/g deceleration vs temperature generated).
    - A heat generation curve with these factors would allow us to understand the rate at which the brakes come up to temp, and at what temperatures we experience brake fade.
    - We would hope to see a linear curve across this as that would indicate that the brakes do not change in feel drastically throughout their heat cycle, as one of the most important factors of a well-designed braking system is that it has a ***consistent feel***. A driver cannot have confidence in their machinery if they cannot predict how the brakes will feel.

Why should we put effort into this?

- By getting real world validation through these tests, we can move closer to closing the loop on the engineering process for our brakes system. Our current math takes us to the heat energy generation stage, however we have not properly validated using real world testing for many of the items before that stage (and it would be a fun learning opportunity : 333333)

Rotor Heat Model

Monday, July 29, 2024 10:46 PM

- I (Emil) previously attempted to model the heat going into our rotors for brakes validation through the use of an excel sheet.

I need to come back and update this lol I finished it I just got busy.

Steering

Tuesday, June 25, 2024 4:49 PM

Theoretical Ackermann %

Monday, January 6, 2025 9:18 PM

A sketch was created in the KS8-E Static Kinematic model that mimics steering. It is adjustable by the rack travel (so basically it mimics a right hand turn).

Ackermann % Equation

Inside Vs. Outside Angle at the tire

I swept across full steering travel just to make sure nothing funky was going on with my sketch.

We want to make a new version of the steering rack tabs but da long way for testing, will need to add hella shims to make toe rods long enough to actually sweep a meaningful area

U-joint alignment

Tuesday, June 25, 2024 4:53 PM

Why?

After looking at various factors including: Tire static friction, tire size, steering geometry, steering rack condition, steering stop fasteners, steering slop, I have narrowed down the last possible factor contributing to the heavy ecar steering to be the ujoint alignment.

While the instant center position moving while the car is moving could be contributing, I think the ujoint alignment is the key contributor, especially because the front ends of both cars should be identical, and the IC doesn't suffer from the same issues.

Plan

- As shown in the photo, we have an idea of what kind of angles the ujoints should be sitting at relative to a flat plane.
- We can either 3D print or laser cut a triangle to the same angles and measure fitment on the current system to determine if the ujoints are misaligned from cad, and if they are misaligned from the IC car.
    - **UPDATE: Seeing as how both of the racks clearly don't appear as they do in the CAD, we should probably actually measure them irl with something that isn't referenced off of the CAD.**
- Blocks will be printed and lined up to ujoints to see if there is any difference in angles from cad

To-Do:
- **Measure angles in CAD**
- **Cad little triangle guy and send to sammy as .stl to print**
- **Put in car and measure**
- **Measure with a tool that is not based on the CAD dimensions**

Initial measurement

Top ujoint dimensions

Bottom ujoint dimensions

Measurement block

IC vs EV racks:
- It appears that the bottom ujoint physically sits at ~180 degree angle on the EV rack entirely because of the mounting of the rack housing being tilted upwards.
- The EV joints are also clearly out of phase, which would contribute to the steering effort, and change the steering feel as the waves of each joint's velocities are not cancelling each other out.
    - EV Rack is not mounted as it in cad, which is what I think the issue is

Whole lota gang shit

IC Steering Rack

EV Steering Rack

EV CAD

Projected Steering Effort

Thursday, December 19, 2024 2:31 PM

- By utilizing the static kinematics CAD model and some basic information with regards to our sus/steering geometry, we can calculate a theoretical minimum steering torque from the driver in a static scenario and in a steady state scenario.

  NOTE: This calculation ignores aero loads on Sheet2, as sheet2 is meant to simulate a steady state left hand turn ranging from 0.1g lat accel to 2g lat accel. For now it also assumes a static tire mu across lat accel values which is not how that really works.

  Spreadsheet link:
  [steeringeffortcalcs (1).xlsx]

  The workflow for the math should go as the following:

This paired with a driver seating position and the 15 year old torque transducer data can be used in design for ergo points, so what comes next:

- When we get the KS8's together we can fixture a torque wrench to the input spline or the steering wheel hub to validate this model and see if our theoretical is close at all for the static calculation.
- We can possibly explore strain gauges on the steering column to actually validate the steady state model (results shown in the graph below)
- While some of those numbers do seem high it is important to note that we realistically never pull more than 1.4g's, and my arm calipers tell me those numbers seem in the ballpark range with how tough our steering is.
- At the end of the day this is 1 step closer to closing the loop on the design.

This curve wouldn't be linear if we didn't assume a static mu value. The next step to improve this estimate would be to take the TTC data and figure out how your Mu changes with respect to lat acceleration. However it does display the correct relationship that your steering effort should increase with lateral acceleration.

Max Steering Lock

Thursday, December 19, 2024 3:34 PM

Thursday, April 10, 2025 10:37 PM

Bias knob joe

Ergo

Wednesday, June 26, 2024 9:54 PM

Ergo Validation/Design Targets

Wednesday, June 26, 2024 9:54 PM

List of companies to email regarding human models for CAD use:

- https://3dhumanmodel.com/info/#contact
- https://www.zygote.com/contact
- http://www.nexgenergo.com/contacts.html

Steering Wheel Design

Saturday, July 20, 2024 11:33 PM

I would like to move away from the Momo COTS wheel design and actually make something in house for the KS8-E.

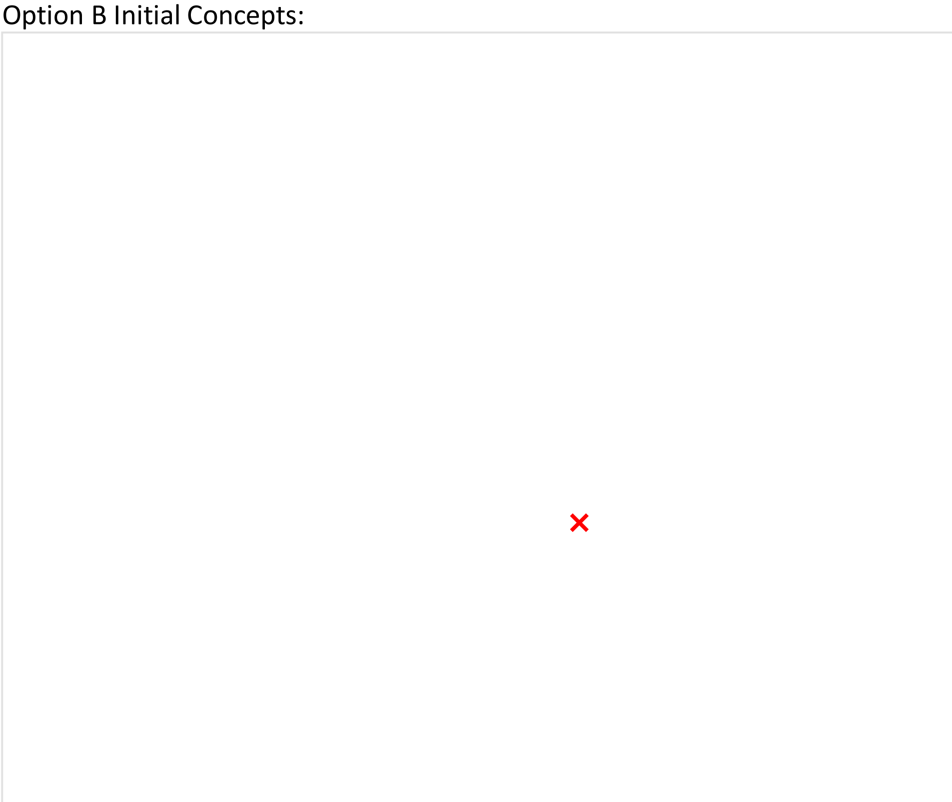
Goals:

- Must be lighter than Mo QWD mo Wheel
- Must have dash buttons integrated into wheel profile
- All buttons must be reachable by any driver from 9th to 95th percentile hand size

Constraints:

- We have not received budgets yet, so I am going to explore two possible options
    - Option A: Fully custom steering wheel design
    - Option B: Backing plate between SPA Hub and Momo wheel
- Option B would be cheaper most likely, but it would make packaging of a PCB (if we want to integrate controls onto the wheel)

Option B Initial Concepts:



1/8th in carbon backing plate, button placements TBD

Seat Inserts

Tuesday, January 7, 2025 11:32 PM

Need to discuss w david still but odds are we just get trash bag with quick foam and mold around drivers

Driver Anthropometrics/Seating Position

Tuesday, January 7, 2025 11:33 PM

Need to gather measurements of all drivers and fill out the spreadsheet in teams

Need to also measure max braking force from each driver idk how to do that yet

Need to build ergo rig and measure everyone.

Ideally we get as close to this as possible in the car (nasa neutral posture), this has been measured to be the most comfortable position that maximizes body productivity.

Additionally we should gather some observational/self-reported data about driver fit.

i. Rapid Entire Body Assessment
ii. Musculoskeletal Discomfort Questionnaire
iii. Driver Survey

Please wait while OneNote loads this Printout...

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iii. Driver Survey

mmsdqall

We can use this as a guideline and assign "scored" values to each category to evaluate pressure Points inside the cockpit. We will need to do this after every session of driving, and it is important to make sure the driver doesn't know this is coming as it is a self-reported assessment.

Would also be a good idea to gather feedback like this, as well as ask how constrained the drivers felt.

JoeErgo.xlsx - Driver Measurements

Tube Frame Ergo Rig Print List

Saturday, May 3, 2025 4:16 PM

- [x] 2x Front Lower Node
- [x] 2x Front Upper Node
- [x] 2x Rear Upper Node
- [x] 2x Rear Lower Node
- [x] 2x Middle Upper Node
- [x] 2x Middle Lower Node
- [x] 2x Middle Center Node
- [x] 1x Front Hoop Connector

PVC Cut List:

1" OD PVC

- [x] 1x 8"
- [x] 1x 8.5"
- [x] 1x 24.25"
- [x] 2x 22.75"
- [x] 2x 26.25"
- [x] 2x 24"
- [x] 2x 28"
- [x] 2x 6.75"

Big Size

1.125" OD PVC

- [ ] 2x 24.25"

Controls

Monday, December 16, 2024 11:25 PM

Pneumatic Shifting Linkage Force Vs. Pressure

Monday, December 16, 2024 11:25 PM

$F_E = \frac{\pi}{4} D^2 \times P$

$F_R = \frac{\pi}{4} \left(D^2 - d^2\right) \times P$

F_E = Force of extension (lbf)
F_R = Force of retraction (lbf)
D = Pneumatic cylinder bore diameter (in)
d = Pneumatic cylinder rod diameter (in)
PSI = Pressure supplied to pneumatic cylinder (PSI)
If extension force in single-acting cylinder, subtract force exerted of spring from applied pneumatic force.

Double-Acting Shift Cylinder @ 120 PSI:
F_E = 106
F_R = 97.2

Single-Acting Clutch Cylinder @ 120 PSI:
F_E = 100
F_R = 6 lbf

Spring force for single-acting clutch cylinder:
3 lb relaxed, 6 lb compressed

Pneumatic Shifting - Spreadsheet

We're sorry, we couldn't make a preview image.

Right-click and pick Refresh and we'll try again

Combining the info on the left with some projected tank sizing math, we can validate pneumatic shifting pressure and tank siz e once we get a running car, or a test bench setup.

Using some equations derived from ideal gas law and q=mcat we can figure out a weight of CO2/N2 used per shift. Once I fix th e IC DIL sim I can estimate a # of shifts per endurance and calculate an optimal tank size. Some important notes about this math - this does not account for multiple points of energy loss throughout the system, so the actual required amount of gas/liquid could be a magnitude larger than what is listed here. However what this does tell us is that fitting a t ank that can reliably sustain our system is possible, and there might be room for weight reduction in said system.

Additionally I added a 25% buffer to how much force is required to actuate the shift lever, as the effort required to shift s hould increase with engine RPM and we have no way to model that relationship until we get the car together. The above graph does give us an idea of what kind of piston size we sh ould be running though. 564+

UPDATE: WEIGHT CALC REDUX
I got really skeptical about the equations I used to calculate the weight of CO2 and N2 being used per shift that I pulled from the MIT pneumatic shifting paper so I wanted to run through the derivation and units before going to IC comp so I could thoroughly justify my use of it

Weight per shift calcs

Sunday, May 4, 2025 12:11 AM

I got really skeptical about the equations I used to calculate the weight of CO_2 and N_2 being used per shift that I pulled from the MIT pneumatic shifting paper so I wanted to run through the derivation and units before going to IC comp so I could thoroughly justify my use of it