

CCSCC Autocross School



April 6, 2019



Rantoul Aviation Center

Today's Schedule

- 8 – 9 Car Technical Inspection
- 9 – 12 Classroom Instruction
- 12 – 1 Lunch
- 1 – 3 (approx) In-car Instruction
- 3 – 4 Wrap-up and final thoughts

What Is Autocross?

Introductions:

Instructors:

- Instructor experience

Participants:

- Why do you want to autocross?
- How long have you been autocrossing?
- Why are you here?
- What kind of car do you autocross?

General comments:

- CCSCC history
- How can we offer Autocrosses?
- Insurance

CCSCC Car Classifications

Nationally Recognized Classes (Ref SCCA 2019 rule book):

Street (9 classes HS->GS->FS->ES->DS->CS->BS->AS->SS)

Street R (1 class SSR)

Street Touring (6 classes STH->STS->STX->STR->STU)

Street Prepared (7 classes FSP->ESP->DSP->CSP->BSP->ASP->SSP)

Prepared (5 classes FP->EP->DP->CP->XP)

Street Modified (3 classes SMF->SM->SSM)

Modified (6 classes FM->EM->DM->CM->BM->AM)

Karts (4 classes JC->JB->JA->KM) *CCSCC insurance doesn't allow junior karts*

Classic American Muscle (CAM-T->CAM-C->CAM-S)

Solo Spec Coupe (SSC)

Comparing across classes -- the Index.....

2019 PAX/RTP Index

- Developed by Rick Ruth used by SCCA and CCSCC to “compare” classes

SS	0.821	SSP	0.853	XP	0.885	AM	1.000
AS	0.817	ASP	0.850	BP	0.865	BM	0.960
BS	0.810	BSP	0.851	CP	0.848	CM	0.891
CS	0.809	CSP	0.857	DP	0.858	DM	0.895
DS	0.800	DSP	0.840	EP	0.849	EM	0.894
ES	0.787	ESP	0.836	FP	0.863	FM	0.907
FS	0.803	FSP	0.824	HCR	0.814	FSAE	0.962
GS	0.788						
HS	0.780	SSR	0.843	SMF	0.841	KM	0.930
HCS	0.793			SM	0.855	JA	0.856
SSC	0.801	CAM-C	0.820	SSM	0.875	JB	0.822
		CAM-T	0.812			JC	0.718
		CAM-S	0.833				
STS	0.811						
STX	0.815						
STR	0.827						
STU	0.828						
STH	0.813						

The Index.....So, how does it work?

Let's say Brian runs a 50 second (flat) in his SS Corvette:

- $50.000 \text{ raw} \times \text{SS Index } (0.821) = 41.050$, this is called index, or PAX, time

Emanuel, in his STS Miata runs a 47.500 raw:

- His index time is $47.500 \times \text{STS Index } (0.811) = 38.523$

Dan runs a 45.250 in a DM Midget:

- His index time is $45.250 \times 0.895 = 40.499$

So Dan gets FTD and Emanuel gets FTDI!

Event Administration:

Drivers Divided into heats

2 heats (up to ~75 drivers): Run 1, Work 1, break in between

3 heats (75+ drivers): Run 1, Work 1, Rest 1

4 heats (100+ drivers, rare at CCSCC events): Run 2, Work 1, Rest 1

Run heat

Line up in grid – Return to same grid position between runs

One lane will be designated for 2 driver cars

Typically 4-6 runs - Return to Pit after last run

Work Heat

Worker assignments -- We can't autocross without them

Timing and scoring:

- AXWare – Timing system used by CCSCC
 - Online registration with ORM
 - Allows Live timing/results
 - Display mounted on Timing Truck
- Multiple Cars on course
- Using a computer with written log
- Posting results
- Trophies, winners & reporting results

Safety Steward:(requires CCSCC certification)

- Focused only on safety of event
- Signs off on course safety
- Controls course “hot” vs “cold”
- Only observes when cars are running
 - Can run event alternating with other SS

Anyone who wants to serve as a CCSCC Safety Steward this year must be trained and certified by the CCSCC Safety Chair.

Waivers:

- Ensures everyone on site has signed off on the insurance waiver
 - Issues arm bands to all on site
 - Arm bands are like Livestrong Bracelets with 100% more checkered flags and 0% doping
 - Issues annual waiver cards
- Keeps all forms for club records
- Works under sweet tent in soft chair
 - Controls Access for Site during Event
 - Protected from rain, sun, hail, Wrath of Zeus

2nd most important job at the event (SS most important). Waiver process enables club to maintain insurance.

Other important jobs:

Starter:(the gate keeper)

- Communicates with Timing
- Releases cars to course
- Sets multiple car spacing

Tech

- Performs safety inspection on cars
- Issues Year Long Tech cards

Pre-Starter:

- Releases car from Grid
- Performs check of helmets
- Verifies 2 driver car numbers

Grid

- Releases Cars in Order to Pre-Start
- Alternates 2 driver cars

How to volunteer so it helps you run better?

Today

- Find Chief of Workers and ask what you can do
- Help clean up after the event

Another event

- Help set up the course (usually Friday afternoon around 3-4)
- Volunteer to do pre-event tasks
 - Unless low turnout you won't have to work during the event
- Ask what tasks are difficult/time consuming and pitch in
 - Club run by Volunteers. If you see a better way to do something work with Autocross Chair to improve

Registration:

<http://www.ccsportscarclub.org/registration/>

- Direct link through CCSCC website
- Pre-registration online: (Paypal)
 - Pre-Reg saves (Lots) of time for Timing/Scoring
 - Saves Money for You
- On site: (cash, credit, or check)
- Car Number
- Car Class
- Car Year/Make/Model/Color

What you need to bring to an event:

- Helmets (Snell 2005 or newer Rating -- M or SA ok)
 - We do have loaner helmets
 - If you're going to buy, get the newest you can find/afford
- Air Gauge -- CCSCC provides an air compressor
- Be prepared for the weather: hot, wet or cold
- No Alcoholic beverages, illegal drugs, ever
- Smoking allowed only in the pits, not on course or in the grid
- No firearms (all of our sites ban them)
- Notebook to keep tire pressures and other helpful hints.

Before You Run:

Tech inspections

- Self-classification
- Year long tech & waiver on file card
 - If you Year Long Tech you are EXPECTED to do everything tech includes before each event
 - Your instructor will tech your car with you before you run today

Before You Run:

The drivers' meeting:

- Held just before the start of the first heat. Approx 10:00
- Everyone is required to attend. Pay Attention!
- Come to the drivers' meeting prepared to immediately go to your work station in case you are working the first heat.
- If you are running the first heat you should be prepared to go get your car and put it in line immediately.

Scoring:

Times -- what they mean

- Raw score -- Indexed score
- Cones:
 - Pointers
 - Normal
 - Special (Start / finish, Defined as special, DNF)

Fun Runs

- May occur after normal event
- Any Registered Car & Driver
- All passengers must have Seatbelts and Helmets

Break: 10 minutes

After Break

Physics of AutoX

(Physics 101... more like 010)

Physics of Autocrossing:

The study of a vehicle in motion is a very complicated subject. Many books and countless studies have been written to attempt to define a vehicle in motion. Despite this complexity a basic understanding of the physics involved can be a help to any driver.

Basic physical laws.

- Physics defines performance of a vehicle. Two primary laws of motion define vehicle dynamic performance
 - Force
 - Inertia/Energy

Force:

Linear Force

- **$F = m * a$** (F=Force, m=mass, a=acceleration)
 - Force is Energy being Placed on the Mass (Throttle, Brakes, Turning)
 - Mass is weight of the vehicle
 - Acceleration is the Rate of change of Motion (It's what we feel and what makes Autox Fun)

Force:

Centripetal Force (Turning/Lateral force)

- **$F = mv^2/r$** (m =mass, v=speed, r=radius of turn)
 - More mass requires more Force
 - More Velocity requires more Force Squared
 - Smaller Radius Turn Requires more force

Cornering “G” nearly entirely independent of Vehicle Mass. Combine above equations $m \cdot a = F = m \cdot v^2/r$ mass cancels leaving $a = v^2/r$ more on acceleration later.

Inertia/energy:

A vehicle in motion wants to stay in motion. It's current motion has an energy associated with it that must be overcome to result in a change in motion (Velocity or direction).

Linear inertia: **$I = mv$**

- More mass -- greater inertia
- More velocity – greater inertia

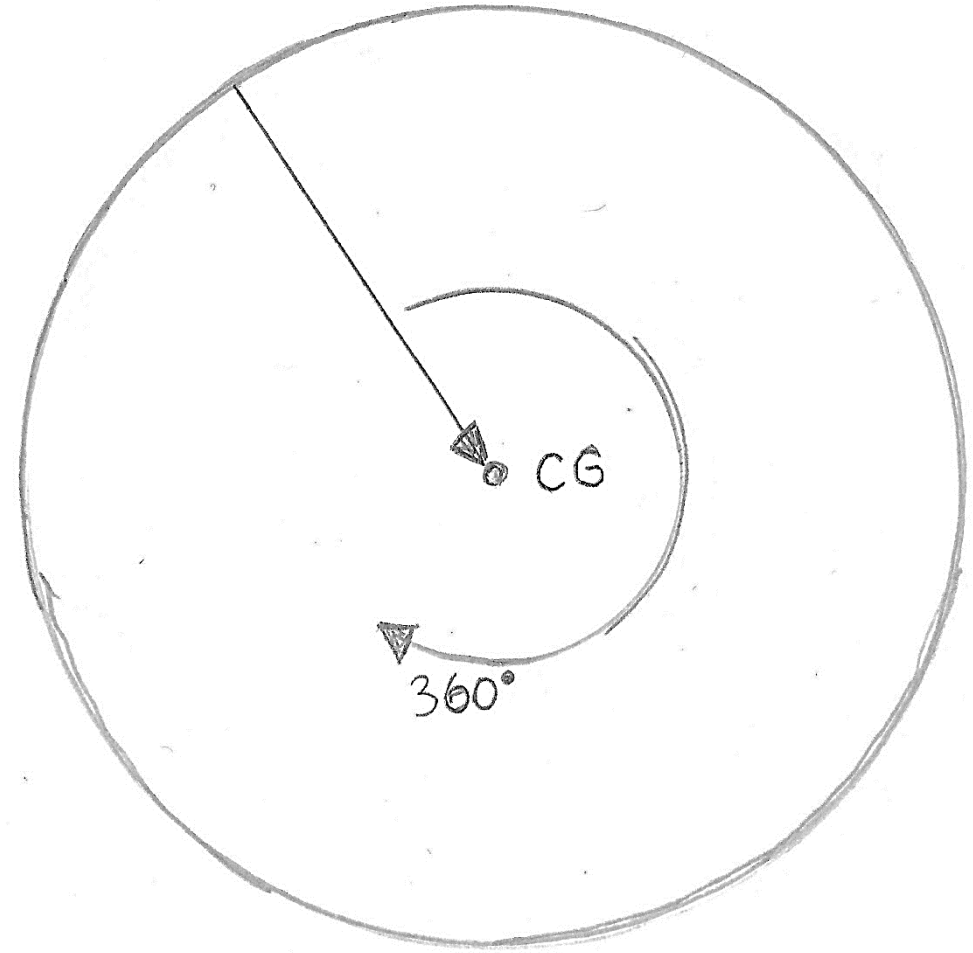
Inertia/energy:

Rotational: all parts of the car have inertia. Rotating the car requires changing the direction of all of these parts.

- Mass towards center of car
 - It turns easily whether you want it to or not -- “twitchy”
- Mass at ends of car
 - It resists changing its turning state. More stable ‘feel’
 - *Rotational Inertia is not “turning” It is “State of Turning”*
- *If not turning -- it resists turning*
- *If turning -- it resists going straight*

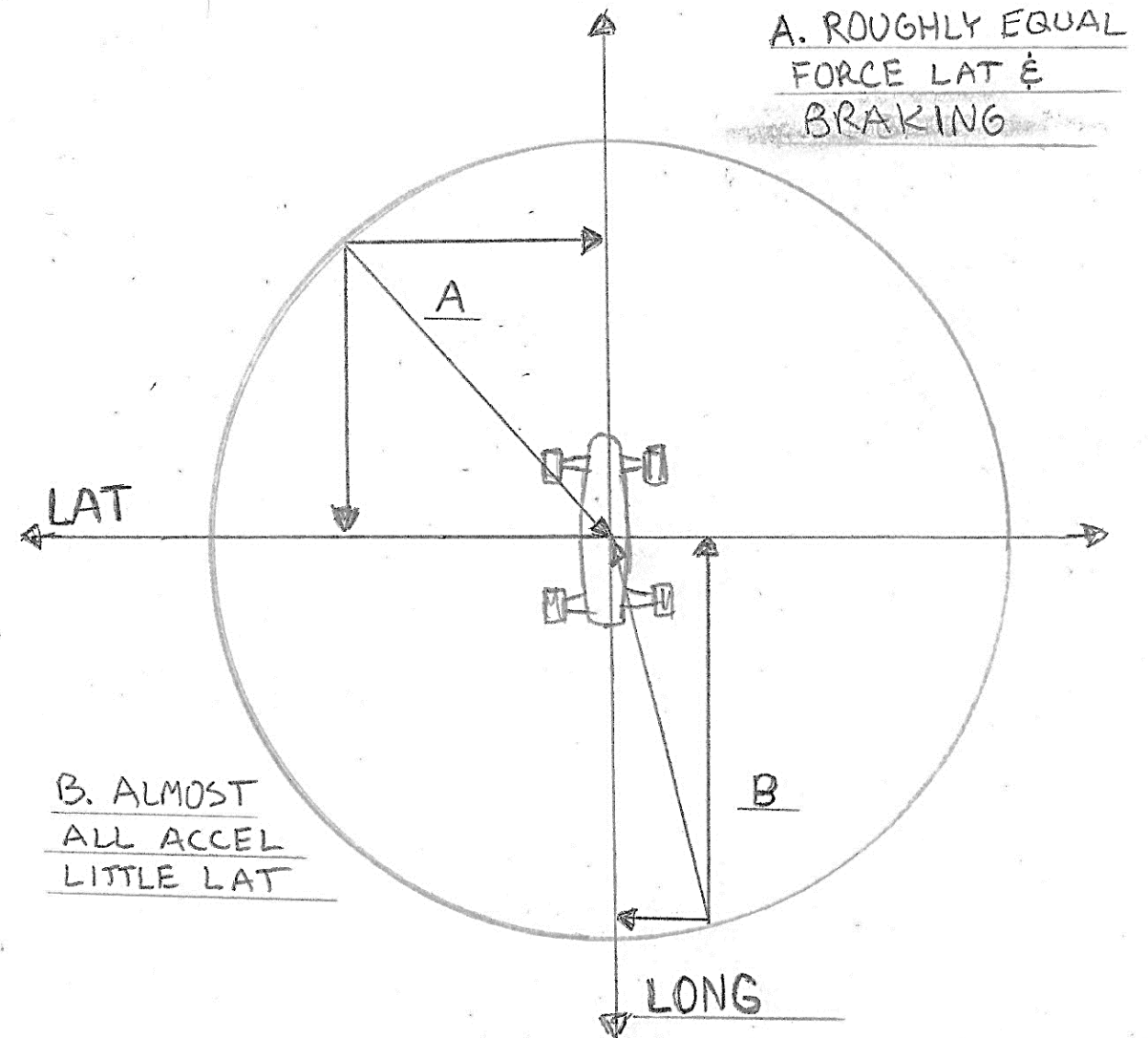
Circle of Traction: Introduction:

- A vehicles ability to accelerate is determined by the total force available to move it.
- Forces (and accelerations) are vectors meaning they have both magnitude and Direction.
- The magnitude of this force is primarily a function of tire grip level and this force can be applied to the vehicle CG from any direction.
- The result is the Circle of traction.



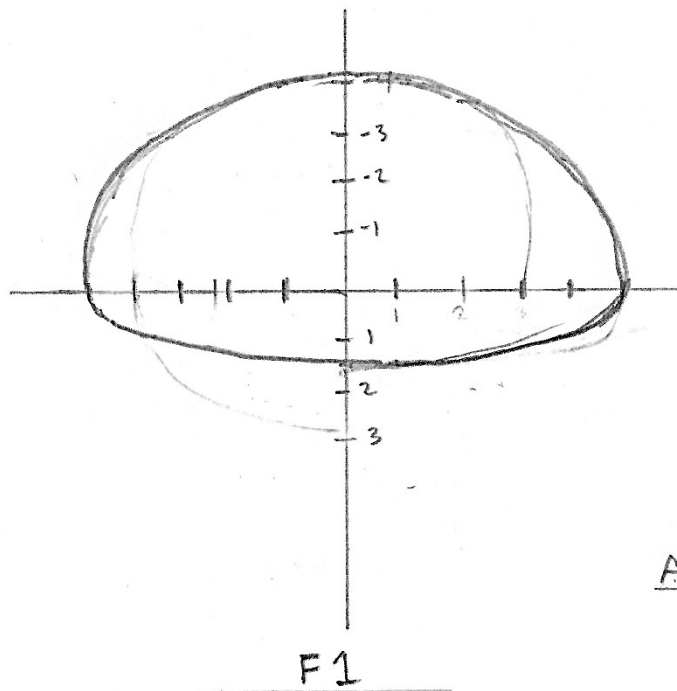
Circle of Traction: Vector Math:

- If we draw an axis on this chart showing lateral and longitudinal force you can see that at any point on the circle the force on the CG is a result of a lateral and longitudinal force component.
- This means that there are times where you can be cornering and still have traction available for braking.

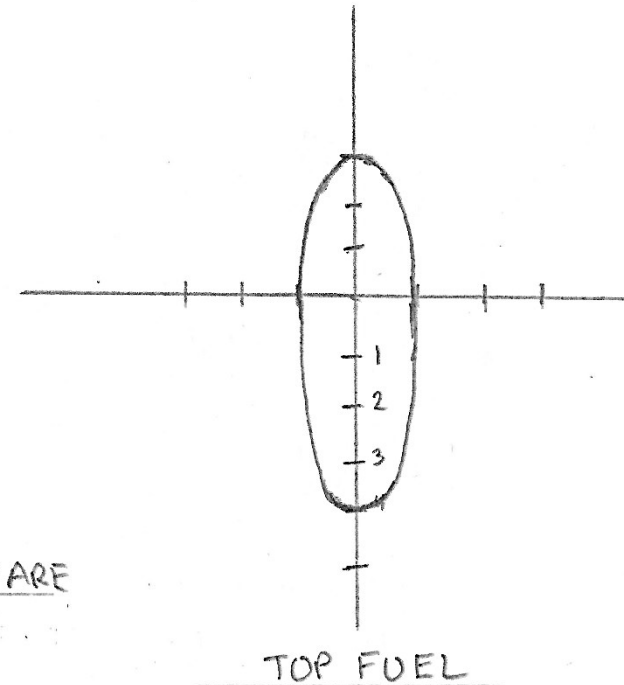


Circle of Traction: Not always a Circle:

- More frequently this chart is expressed as “G” loading
- This is achieved by converting the Force into acceleration and dividing by acceleration due to gravity.
- In the real world the shape of the “circle” may be irregular due to vehicle characteristics however the effect is the same

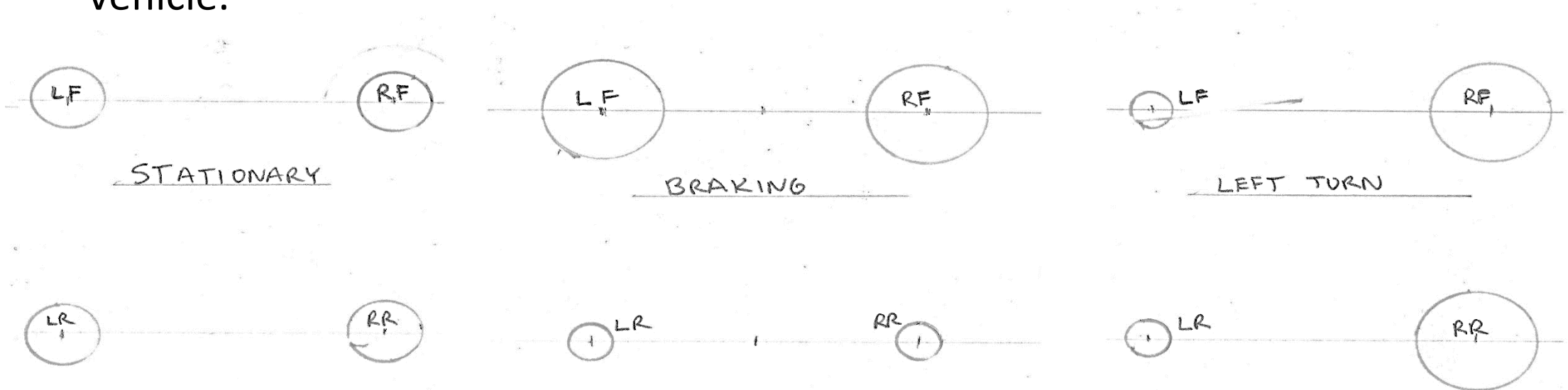


APPROX COMPARE



Dynamic Motion: 4 Tires Contribute Force:

- A car experiences the result of the forces of all 4 tires.
 - That means that each of the 4 tires provide a force that acts on the car.
 - We can visualize this as 4 small circles of traction representing each tire.
 - The diameter (Total available force) at each tire is determined by the dynamic situation that that tire is experiencing.
- Vehicle dynamics is the interaction of these forces and the resultant force on the vehicle.



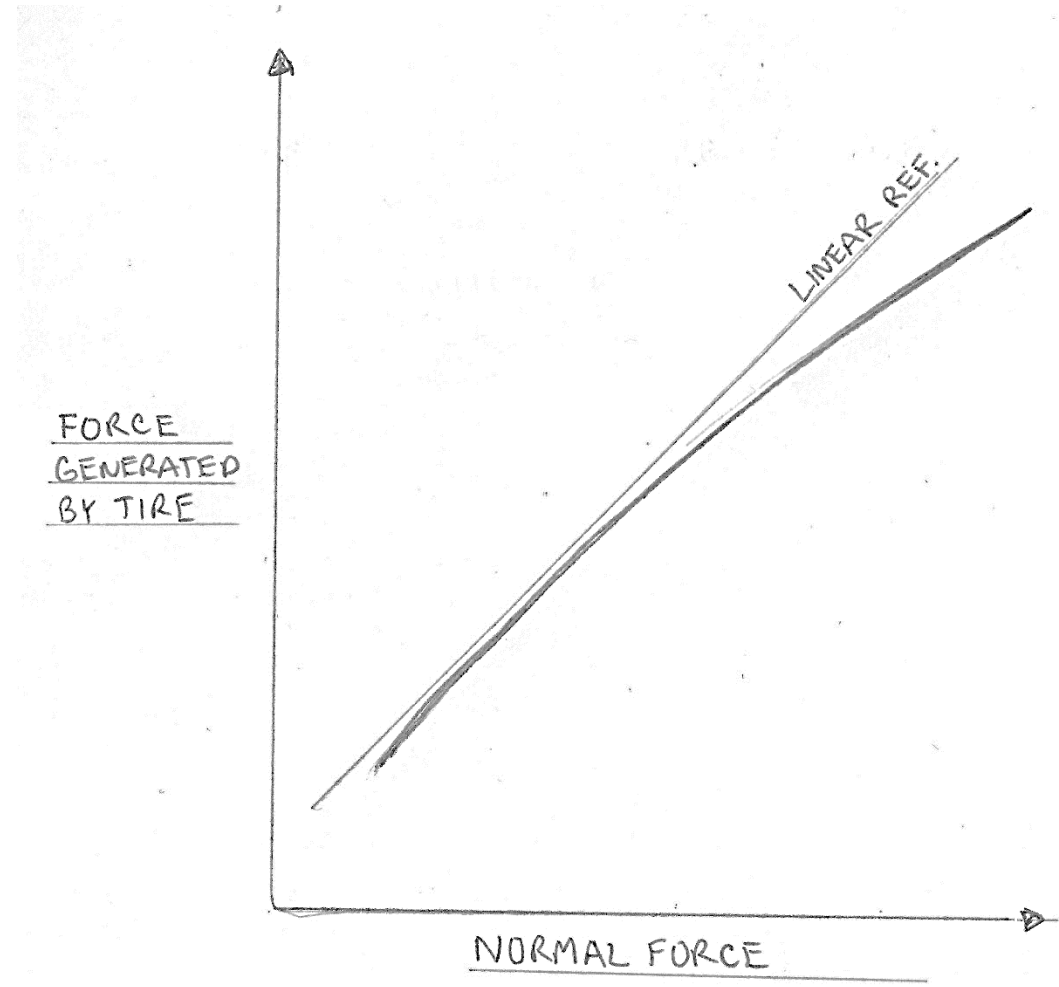
Tire Behavior: Grip as function of Dynamics

- Tires generate force as a function of the coefficient of friction multiplied by the normal force (Weight) on the tire.
 - If only it was this simple.
- Since we are moving and applying dynamic loading to the tire as well as changing its path of travel it is important to understand how the tire responds over variable inputs.



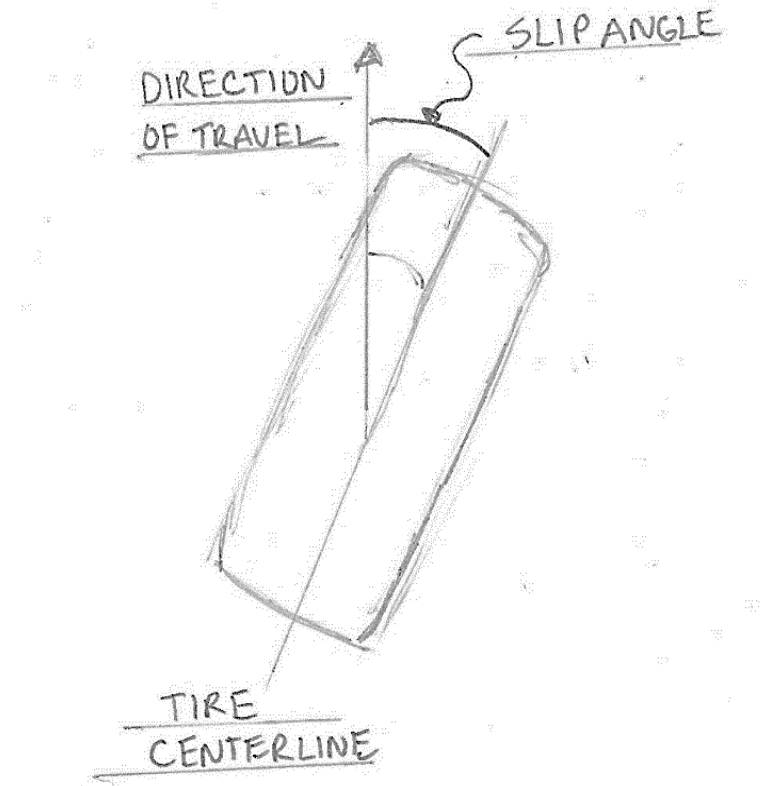
Tire Behavior: Weight

- As weight is increased on a tire the coefficient of friction decreases slightly.
- This results in a force that does not increase linearly with weight increases.
- Weight is transferred during dynamic motion.
- Due to tire behavior this ALWAYS decreases total available grip.



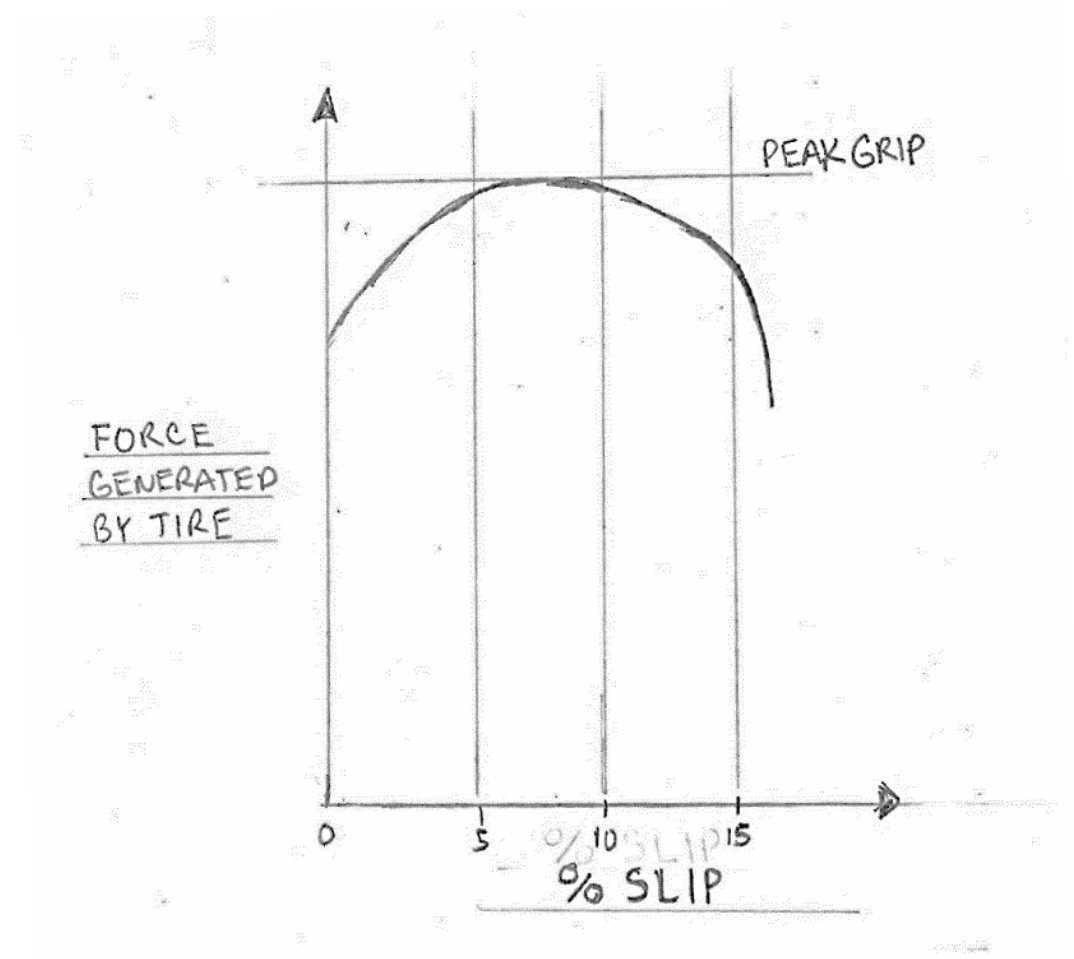
Tire Behavior: Slip Angle

- The contact patch of a tire is in stationary contact with the ground even while the vehicle is in motion.
 - Expect the coefficient of friction to be highest when this is true. With Tires it's not.
- Tires grip are at their highest when they are sliding some relative to the ground.
- This is known as slip angle and is most easily visualized with a turning tire as the angle between the tire centerline and the path of travel.
 - It also applies to Acceleration and braking



Tire Behavior: Slip Angle

What happens before and after this peak and how wide this peak is are important characteristics of tires to understand.



What does all this mean?

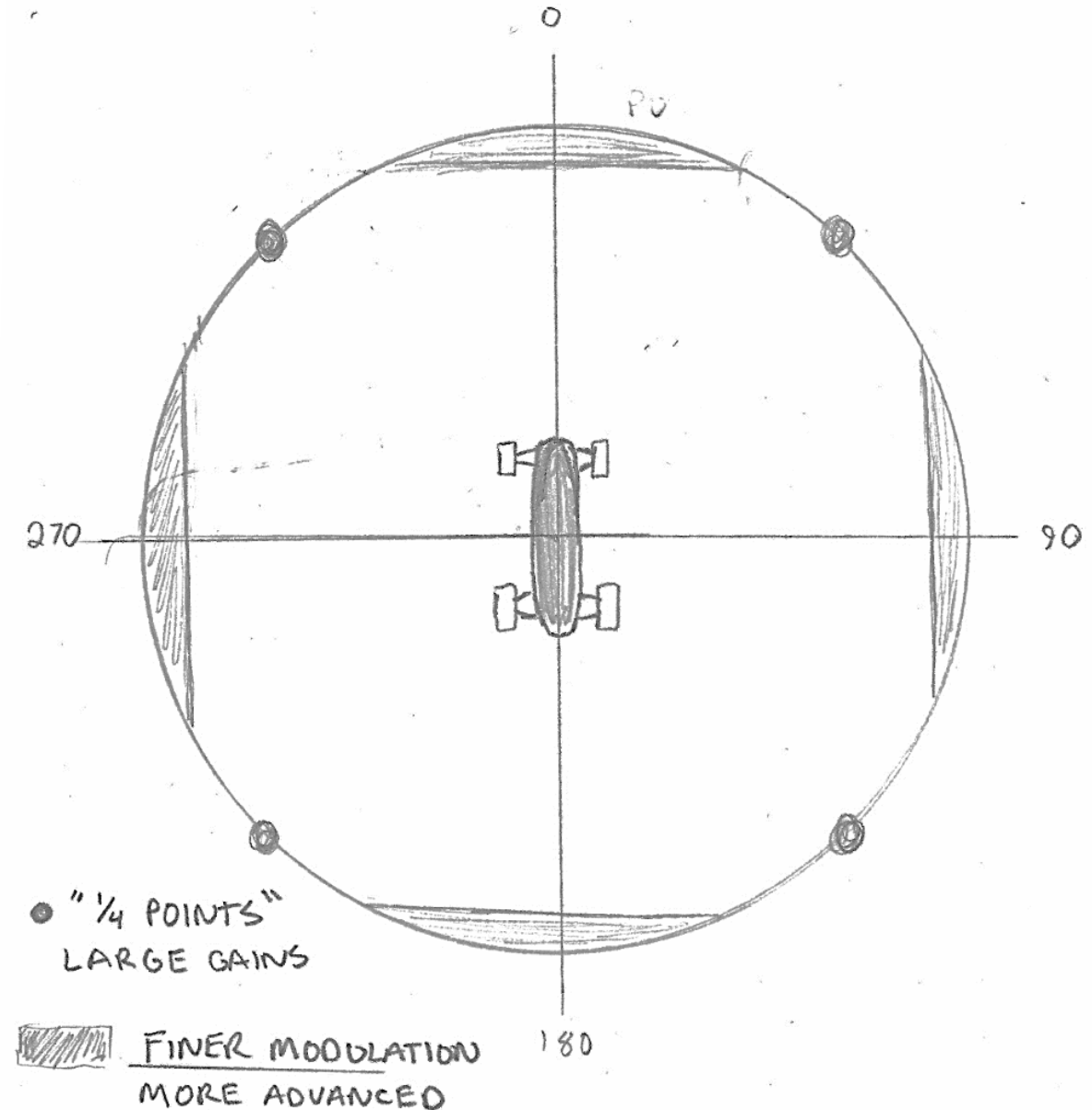
- This is a very simplified representation of the concepts involved.
- The reality of what goes on is complicated by:
 - suspension geometry
 - spring rates
 - chassis dynamics
 - Alignment
 - Temperature
 - surface conditions, and so on.
- Despite this we can take away a few things from the idealized view.

Physics Takeaways

- Smooth inputs
 - Vehicle dynamics are all about transitioning between different forces. Being smooth in your inputs makes it easier to feel what is going on and less likely to “overdrive” the car.
 - It’s very difficult to throw the car into a corner and expect that you will arrive at precisely the correct combination of slip angle and cornering force that you require for the line you are on.
- Drive what you have
 - Certain behaviors are characteristics of your vehicle, or of your tires.
 - Learn to exploit the full traction circle for your vehicle.
 - Exploiting the edge of traction is a more valuable skill than making the circle bigger.

Physics Takeaways

- Feel the Grip
 - Learn how to feel the tires as they approach and exceed the peak slip angle.
 - Work on the $\frac{1}{4}$ points of the traction circle first. The gains here are substantial.
 - Finer modulation of Lateral and longitudinal grip (Trail braking, Mid corner throttle application) are much reduced because of the limited force available at the more pure lateral or pure longitudinal points on the circle



Physics Takeaways

Slow is Fast

- For the beginning driver (and most advanced ones) it is faster to be approaching the limit from within it.
- The line around the cones should be such that there is no traction margin.
- Once you have gone too fast into a corner you're done - it is simple physics, you must slow down to get back on line.

Break: 10 minutes

After Break

More Tips, Tricks, and Guidance

(we hope)

Choosing a car to autocross:

- What do you need the car for?
 - Family/Daily Driver (Street Classes)
 - Fun on the street, Fun to Autox (ST & CAM classes)
 - Multi Use, Road Rally, Rally Cross (Street/ST)
 - Dedicated autocross car (SP, Prepared, Modified)
 - Road Race Car (All SCCA RR cars have a class they fall into in Autox)
- What do you want to run for
 - FTD (Modified Classes, Kart)
 - Class win (look at national results and buy that car)
 - Against yourself: Buy anything, modify how you want, keep it safe and passing tech and have fun

Car set up

- Tire pressure
 - Reading tires
 - White shoe polish or window chalk
- How pressure affects handling
 - More traction -- more tire on ground
 - Increase pressure, Decrease Grip
 - Lower Pressure, Increase Grip
 - Cost, Increase wear, decrease feel
 - How much pressure?
 - Depends on tires, type of car, type of surface, front or rear of car
 - Good starting point is 5 psi over manufactures recommended for your car.

Car set up: Modifications

- What to take out before your run -- reduce weight
- Alignment
 - Have a competent shop (or yourself) do a “performance” alignment
 - Marque specific forums are good source for alignment specs for your car
 - Ask CCSCC drivers who does their alignment and what specs they run
- Tuning
- The honor system -- and self-classification
- Seatbelts & Harnesses

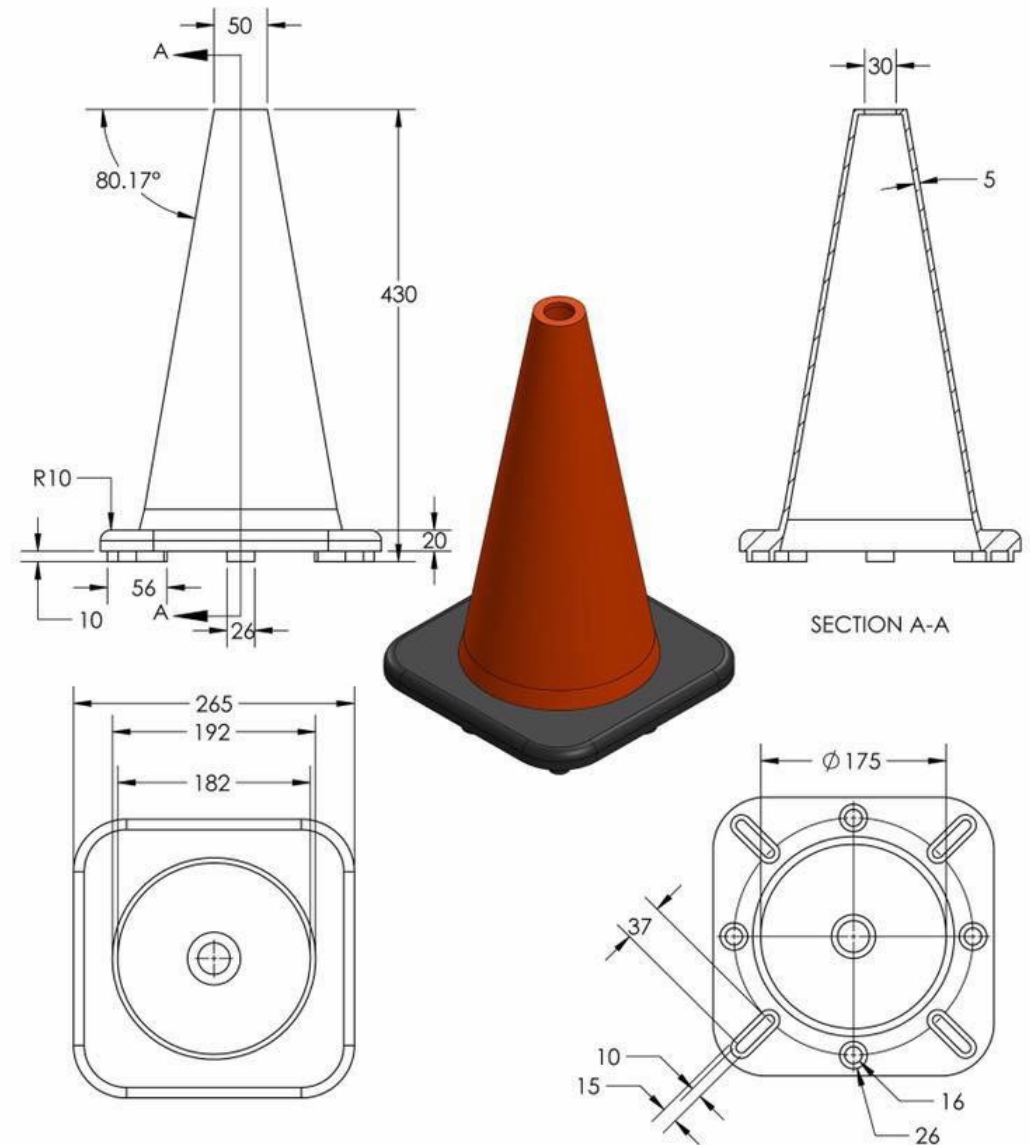
Car set up:

- Numbers and class
 - Readable
 - Unique per car
 - Both sides
 - Year long numbers
- How much gas to run?
- Cameras

Walking the course:

- What should you be looking for (cones)?
 - Optional Elements
 - Increasing / Decreasing slaloms
 - Increasing / Decreasing Radius turns
 - What are the distances?
 - Who to walk with and who to listen to?
 - How many times?
- Before you walk review the course map (If posted) or make your own
- Pay attention, don't shoot the breeze

KNOW YOUR ENEMY



Driving instruction

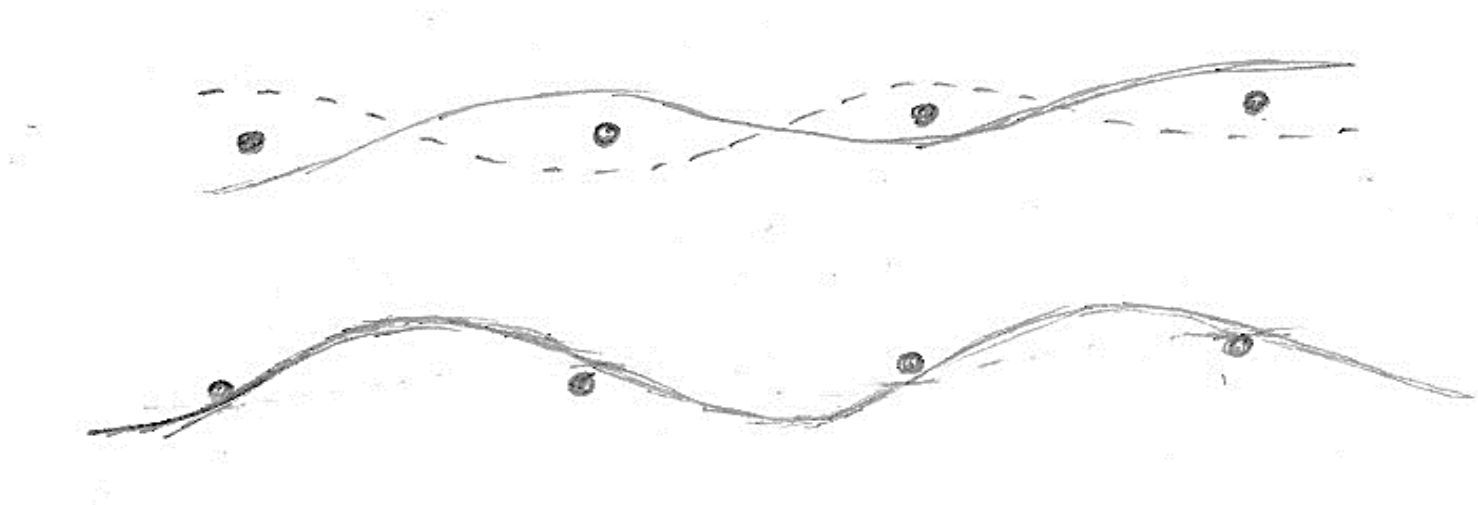
- What and where you should be looking
- Driver location (hands & feet)
- Taking off from the starting line
 - Go through the course in your mind while waiting
 - Start in a reasonable time, but when you are ready
 - Look ahead

Shifting

- How, when, why
- Upshifting
- Downshifting
- Clutching
- Keep both hands on the wheel except to shift

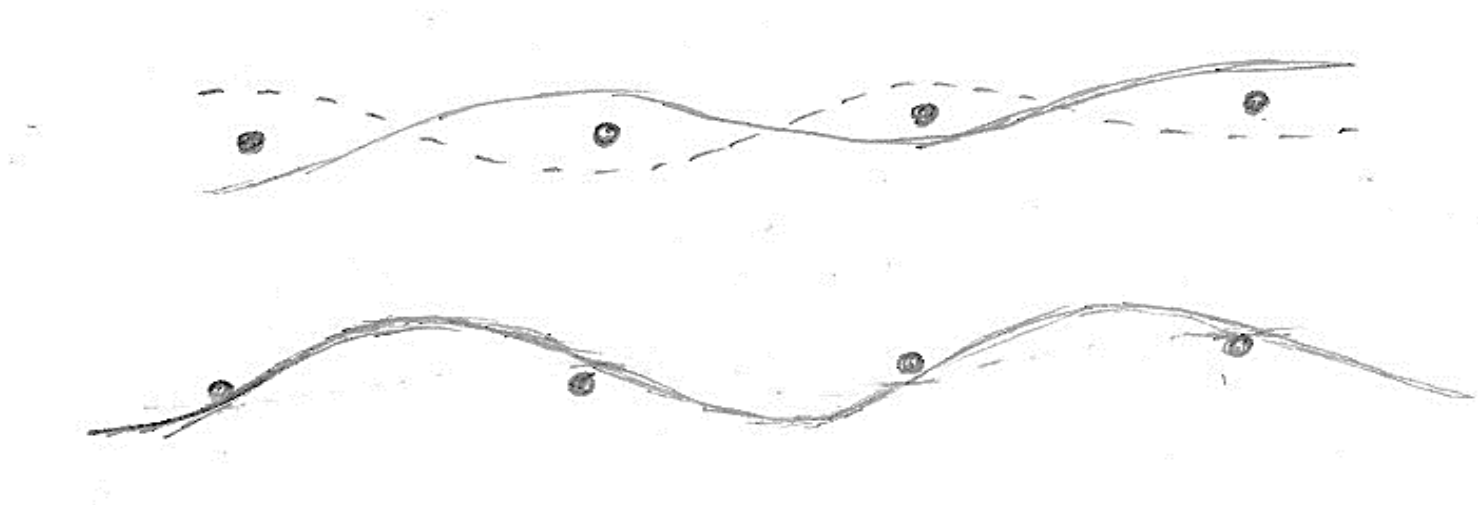
Course Features: Slalom

- Pointers
- Pay attention to spacing. Offsets effectively shorten or lengthen spacing
- “Get behind” the first cone
- For longer slaloms 2nd-3rd cone gap is the important one watch the 3rd cone for gauging entry (See graphic)
- Off course if you don't alternate sides/On course if you hit the cone



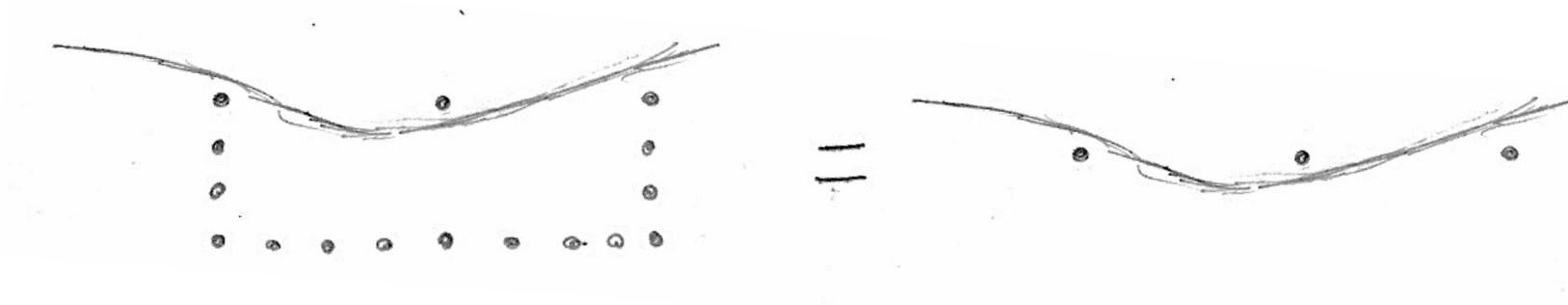
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Course Features: Other Slaloms

- Forced Slalom
 - Same as normal except enter opposite pointer
 - Pointer doesn't count if you hit it
- Chicago box
 - Really a 3 cone slalom with “distractor cones”
 - Enter “behind” entry cone, look through exit, drive out
 - Try to enter to reduce turn in so it's just a 1 turn feature (don't make the 1st cone a slalom)

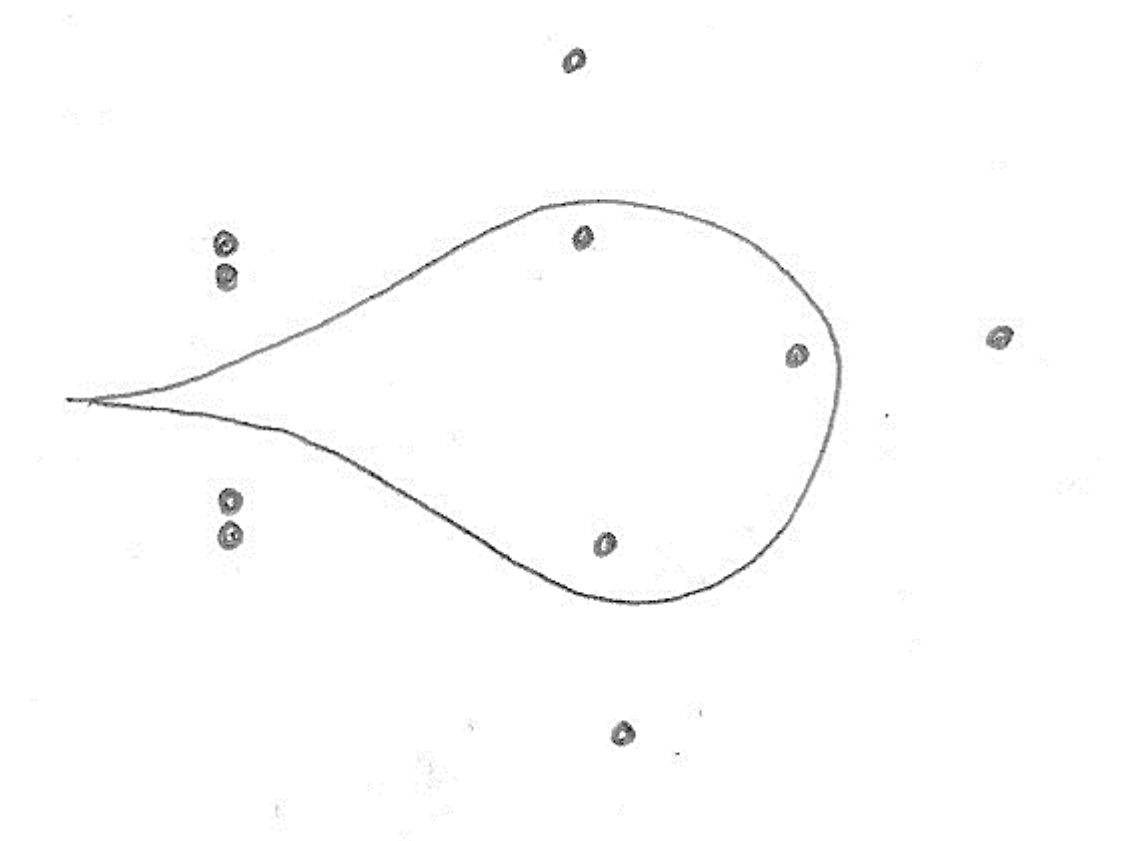


Course Features: Corners & Sweepers

- Corners
 - Pacing off
 - Imagine where you will be going
 - Getting a "rhythm" going
- Sweepers
 - Smooth
 - Apexes: Early, Late, Multiple
 - Smooth (in case we forgot to mention it)
 - Where do you want to go? Look there

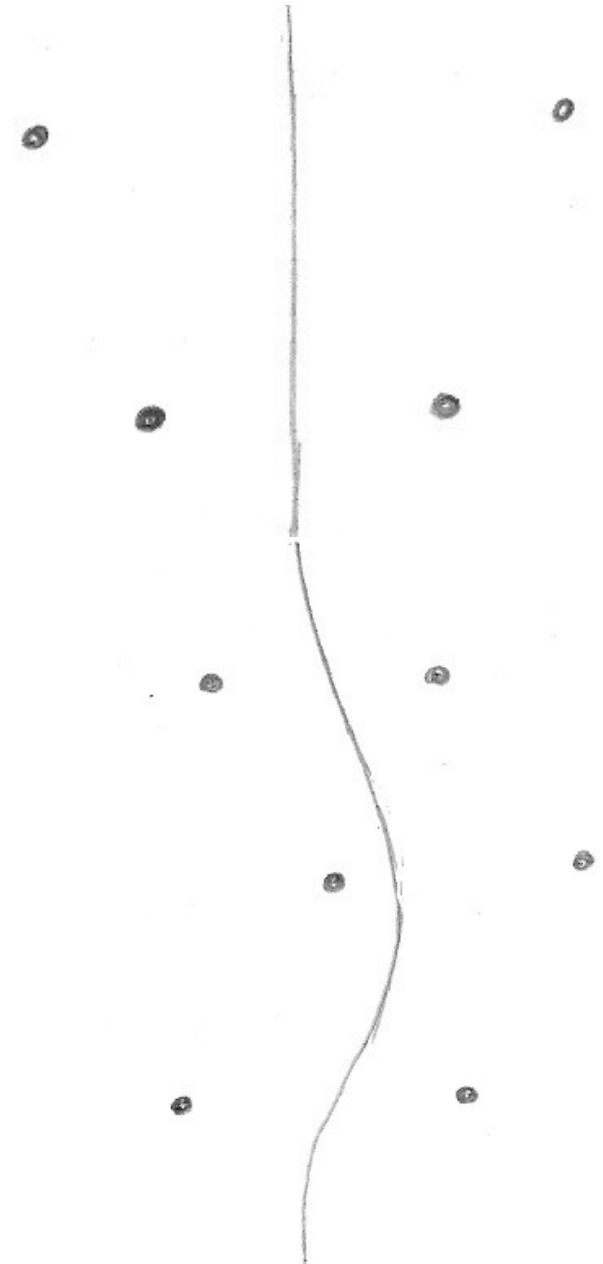
Course Features: Hairpin/Double Gate

- Hairpins / Lightbulbs
 - Slow Down
 - Choose a line that suits your car
 - Late vs early apex
 - Consider what comes before and after hairpin to determine which side to maintain speed
 - If Optional, determine the best Direction to turn
 - NO Handbrake Turns!



Course Features: Gates

- Look ahead and set up for the next one
- What if you are going to miss it? (Accept this run will not be a winning run)
- Don't back up
- Get the pylon
- Drive intentionally to the next corner



Course Features: Finish

- STOP racing!
- You don't win after the lights
- Cost of lights....
- Watch the pylons
- Large cones DNF run
- Exit chute cones DNF run
- **Don't stop in exit chute unless directed to**
- Walking pace after exit chute



General Course Flow

- Always consider what comes next when planning lines
- Generally Shorter distance is faster in Autox
- Pay attention to surface conditions, bumps can impact available traction and may require adjusting line
- Identify 4-5 key cones/elements that will define your line and get those right
- Generally a turn only has 3 cones that matter
- Setting up for these elements correctly allows you to drive the connecting elements more easily.
- Maximize speed coming into acceleration areas. Speed given up on entry affects you the whole time you are accelerating

Helpful Hints:

- Watch those in cars like you
- Get where you can see others run (other heat, your heat)
- Don't take the event nor yourself too seriously
- Get to know an experienced driver who can mentor you
- Read your tires after your first run
- Adjust tire pressure until the car feels right
- Once your run feels good, concentrate on your driving -- forget the pressures.

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More Helpful Hints:

- Go over your run in your head as soon as you finish. Focus on where you can improve. Ask your mentor to watch your run BEFORE the run
- Ask where you went off course, but don't ask the workers
- Have fun and expect to get beat sometimes. Be a good loser
- Be a good winner
- Remember -- you are running mostly against yourself. Are you happy with your run?
- Slow down to go fast
- Don't look like a police car on TV
- Don't overdrive

References/Resources

- **Web Resources:**

- CCSCC Website: <http://www.ccsportscarclub.org>
- Central Illinois Region SCCA: <http://www.cir-scca.org>
- SCCA Indianapolis Region: <http://www.indyscca.org/>
- Permitted SCCA Mods: <http://www.sff.net/people/dburkhead/prepcompare.htm>

- **CCSCC Resources Online:**

- CCSCC Website: <http://ccsportscarclub.org>
- CCSCC 2018 Autocross Schedule: <http://ccsportscarclub.org/autocross/schedule/>
- CCSCC Online Pre-Registration: <http://www.ccsportscarclub.org/registration/>
 - To Pay for a CCSCC event with PayPal, use Paypal link in registration

Questions?



NEMESIS

I'll get you my pretty...
...whether I want to or not.