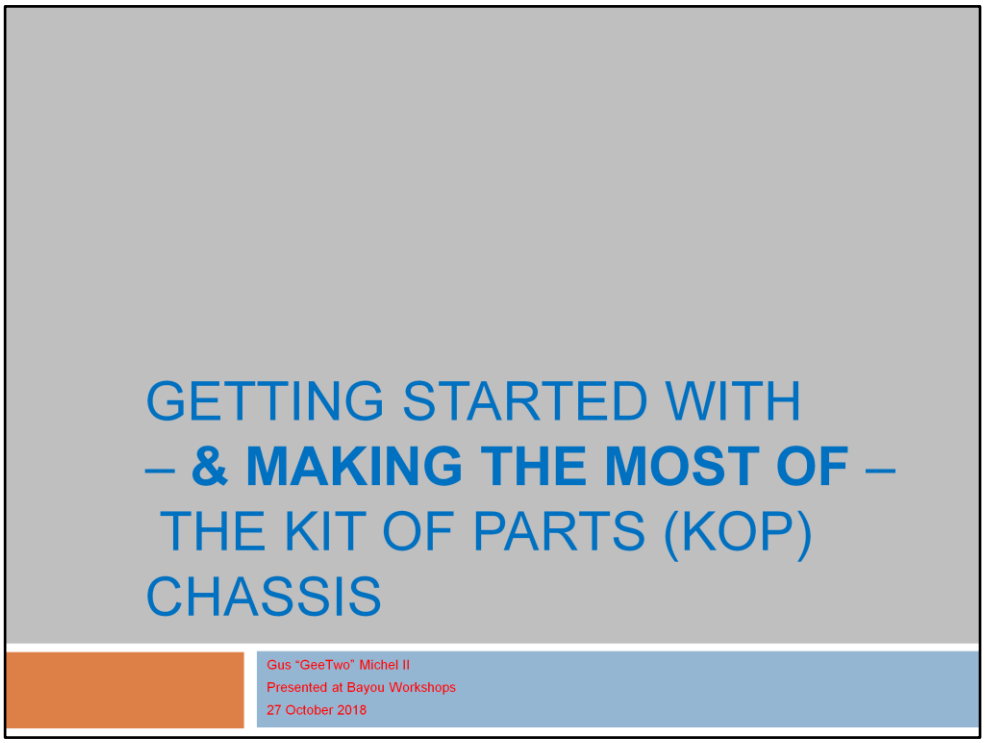
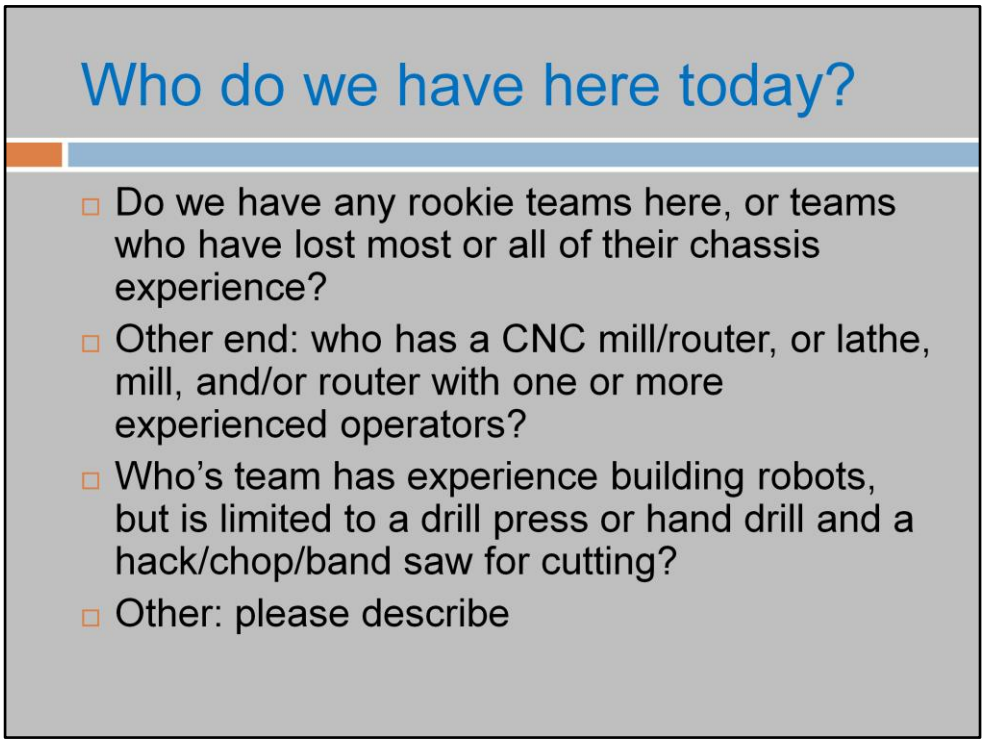
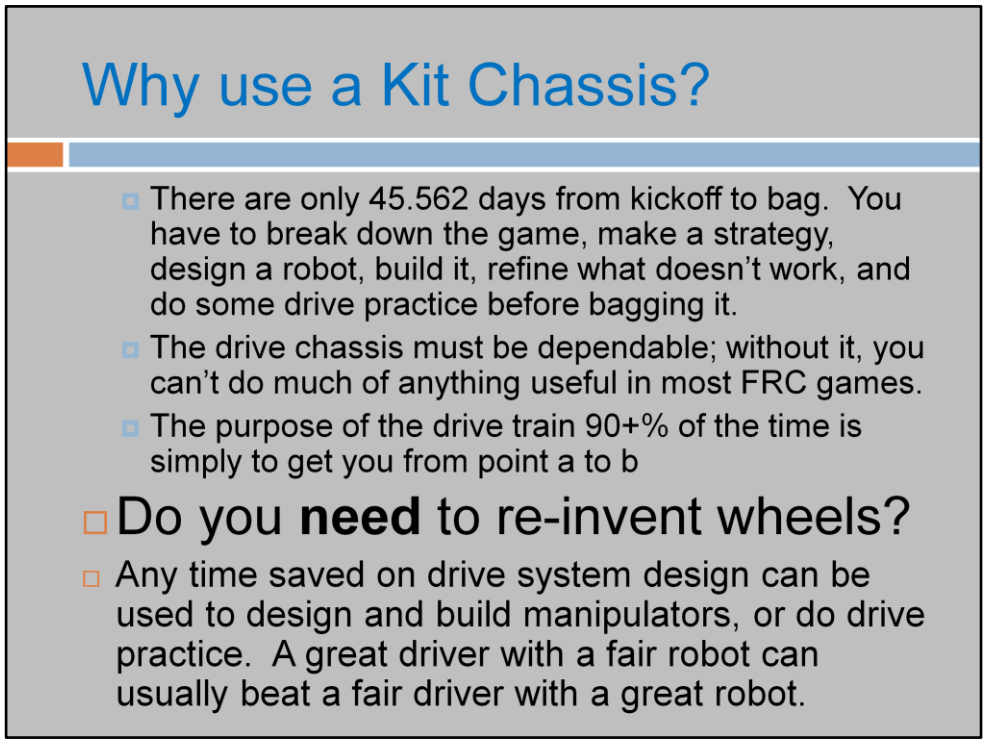



Post-presentation version




Just feeling out the audience. I'll tweak the presentation as needed. Group #2 is likely to be bored, at least until late in the presentation.




45 Days, 13 hours, 29 minutes, to be precise. (.001 days is 1 minute, 26.4 sec).

OBTW, this same argument is also worth considering and adapting to any time you are considering using COTS vs rolling your own. The take-away is that if a COTS solution I available, you should have some specific requirement (whether functional or process or experiential or otherwise) to decide NOT to do COTS.

# A Great Way to Build Two Robots

- Building two robots is a great way to work around the Bag Day limitations – get more iteration time, get more drive time.
- Using Kit robots is a great way to make both chassis the same.
- Using VersaFrame is a great way to make the manipulators the same (more later)
- 3946 has bought two “frame only” robots recently and re-used gearboxes and wheels. The “Square Deal Edition” is a good intermediate step.

## What Kit Chassis are available?

- [FRC Blog]: The 2019 Drive Base Kit.
  - It's similar to the AM14U3 from 2018, and includes a bumper and battery mounting kit.
- AM14U3 (no batt/bumper) is available at AndyMark for $656
- AM14U3 Square Edition: 4" wheels, 8.45:1, four belts, $438.
- The AM14U3 frame parts plus bearings: ~$200. An inexpensive way to build two robots if you have the other parts on hand.
- The AM C-channel chassis frame (2012-13 KoP) is available
- AM has nanotube chassis sets from about $600 to $1,000
- Vex Versachassis and West Coast Products have options which are not quite to "kit" standards, but can be used to build a viable FRC chassis for under $1,000.
- The remainder of this presentation will be on the AM4U3 and evolutions thereof.

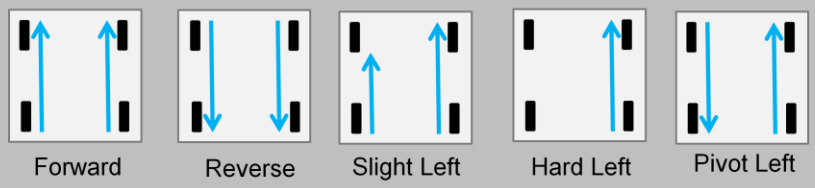
Note that the C-channel frame is designed for an out-of-line gearbox output shaft, and requires three chains per side. This may make it slightly less dependable than a West Coast Drive or other chassis with one or more gear-only driven wheels.

Nanotube is available in 20" and 31" lengths, and has two gearboxes (each with one CIM) per side. Great for mecanum, not so great for differential drive. Both 20" and 31" have "dead" center axle mounts which may be chain driven – or by an extravagant (and heavy and expensive) number of gears.

West Coast/Versachassis chassis typically have "cantilevered wheels", which means that under the rules for all the recent games except 2015, bumper standoff mounts will be required.

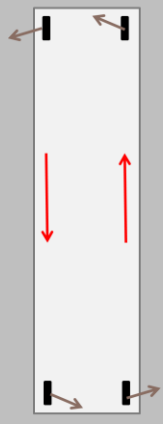
# How do you steer these robots?

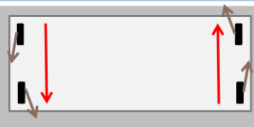
- Except for the mecanum option, steering is via a "skid-steer" or more colloquially "tank drive" or (recently) "differential drive" steering.
- All the left wheels are on one drive train, synchronized by belt or chain, and all the right wheels are on another equivalent drive train.
- Steer by moving drive trains at different speeds



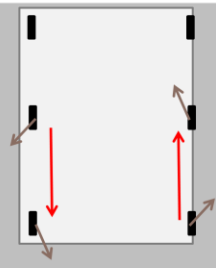

More details about this slide and the next and some of the options later on can be found at the two Drive System primer briefs available at https://www.chiefdelphi.com/media/papers/3175. There's an engineering process brief there, too.

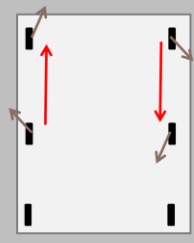
# Why do most skid-steer robots have six wheels?





- A long 4-wheel robot (left) can't turn!
- A wide robot (top) turns easily, but falls over front/back easily as well.
- Six wheels with a "drop center" (right) allows a robot to turn as if it has a wider track while exhibiting stability of a longer wheelbase.
- Bottom Line: A 6-wheel robot is expected to "rock" slightly from back to front; this is a design feature, not a flaw.





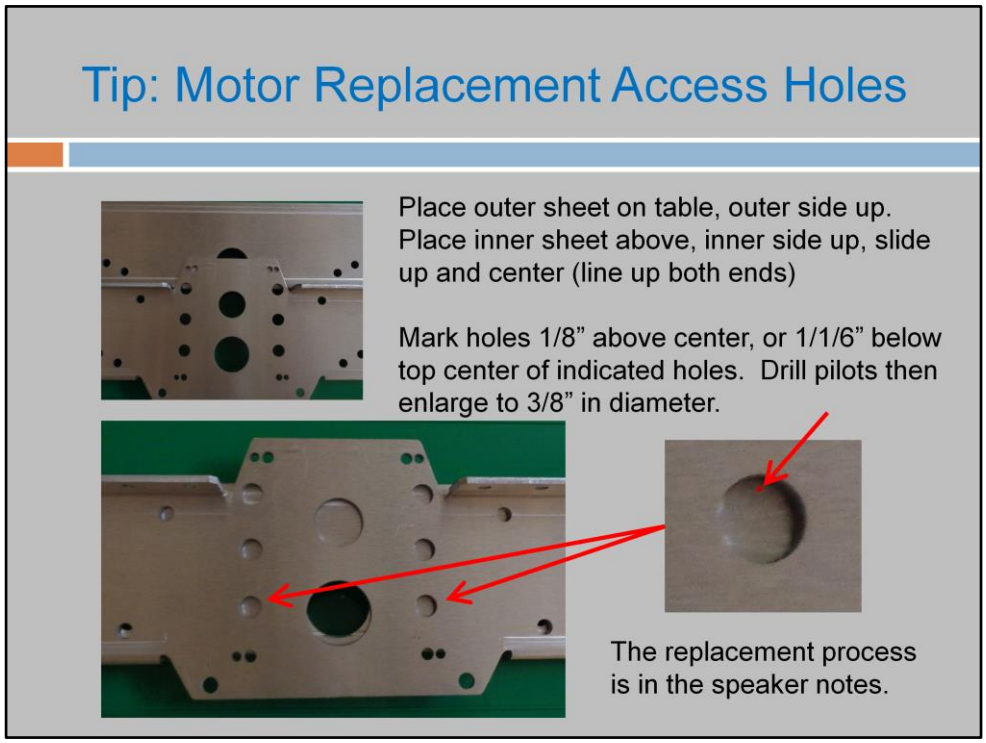
## Before Assembly


- RTM (Read The Manual)!

1. Select chassis size*, gearing, wheel size and placement based on the game and your strategy (see COTS and non-COTS options later).
2. Order any needed parts
3. Mark the frame cuts, including long churros.
4. Do a "mock assembly" to ensure things line up
5. Cut the frame members as needed
6. (optional) Drill motor access holes in outer sheets as shown on next slide.

I do not recommend pre-assembly of the chassis, unless it is to support programming or meet some other specific need. You'll almost certainly need to partially disassemble it to cut something down, and have to put it back together. As far as I can recall, the full size KoP chassis would only have been legal in 2015 going quite a ways back, and then only for a short robot, or one which could be reassembled in minutes.

- The past four years, the maximum chassis size has been calculated four different ways. Not just different numbers – different things being measured.
  - 2015: "Transport Configuration" was all that mattered laterally. Maximum height limit for both initial and game configurations.
  - 2016: Frame perimeter maximum, plus separate maximum heights for starting and play configurations. Maximum frame extension during play.
  - 2017: The robot INCLUDING BUMPERS AND ARMS had to fit in one of two sizing boxes
  - 2018: Startup sizing box which did not exclude "minor protrusions" originally, but later did. Maximum initial height, maximum frame protrusion during play.




Motor Access holes: The inner sheet has access holes to allow removing/replacing motors without removing the gearbox from the sheet. There are two distinctive columns of three large holes (~3/8") about 1-1/2" forward and aft of the center of the sheet. The center of each of these is unnecessary. The top holes can be accessed using a long (5/32") ball-end allen wrench going over the outer sheet. The bottom holes cannot be accessed with the outer sheet and belts in place. Drill holes about 3/8" to ½" in the outer sheet to permit access (will still require rotating wheels to get there).

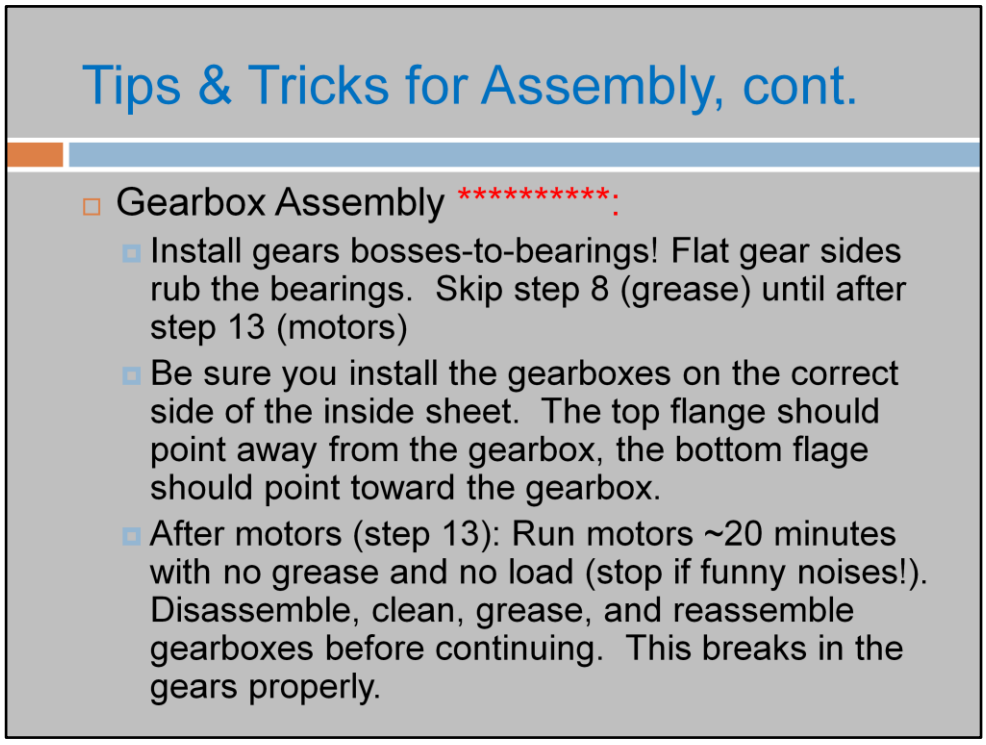
By rotating the wheels to the proper orientation, you can reach through most 6" and 8" solid tread wheels (not mecanum or omni or pneumatic).

To replace a motor, I recommend laying robot on its side so that the motor(s) to be replaced are at the high end. Remove one screw halfway, remove the other completely, then finish the first screw. Be sure the screws stick out of the gearbox housing as you remove the motor. Then replace the motor by threading both screws before tightening either.

## Tips & Tricks for Assembly


- Follow the User Guide as you build; the order of spacers matters!
- Assembling pulleys to wheels:
  - Corner wheels only need one pulley each and use bearings; the center wheels need two pulleys and a hub.
  - Three equally-spaced screws per pulley is sufficient, and leaves extra holes if you need to re-do.
  - DO NOT OVERTIGHTEN PULLEY SCREWS! They're quite difficult to remove should they shear off inside the wheel – and they do.

Note that the pulley screws are NOT used to transmit torque – the meshing of the wheel and pulley takes care of this. The screws just keep the wheel and pulley from coming apart.




Running the TB-mini without grease is unfortunately NOT listed in the KoP instructions, but if you look on AndyMark's website for assembling a stand-alone gearbox, you will find the recommendation of installing without grease, running in, then cleaning and greasing.

## Key Items and Tricks for Assembly, cont.

Frame Assembly:

- After installing churro standoffs on inside sheets, assemble inside sheets and end plates. Outboard of the inside sheets, there should be 5 empty holes on the top side of the end plate, and 7 on the bottom side.
- Then, Install wheels and outside sheets. You may want to use “rack clips” (cage nuts) to secure the outside sheets to facilitate assembly and disassembly.

Modifying the order of assembly will better prepare you for removing and replacing the outer sheet if you need to swap out a wheel, pulley, belt, or gearbox. (or motor if you did not make access holes). Stuff happens; be ready.

I suggest rack clips/cage nuts (https://smile.amazon.com/gp/product/B071F3NJXF) for the outer sheet mounting, as this will make removal and replacement after wheels are in place MUCH easier.

3946 has used “rivnuts” in the past which was an improvement over the bolts and nuts in the kit – until a rivnut started to spin, when it became a nightmare. I do not recommend those.

# AM14U3 COTS options < $400

- Gear changes (5 different speeds/torques)
- Belt changes (change wheel spacing)
- 4” or 8” wheels (clearance, speed, torque)
- Pneumatic wheel kit (rough terrain)
- 8 wheel kit (high ramps)
- Omni wheels (easy spinning)
- Frame Opening Kit (bring cubes part-inside)
- Wedge Plate (vertical curbs)
- XL end/wedge/cross plates (really wide robots)

# AM14U3 Upgrades >= $400

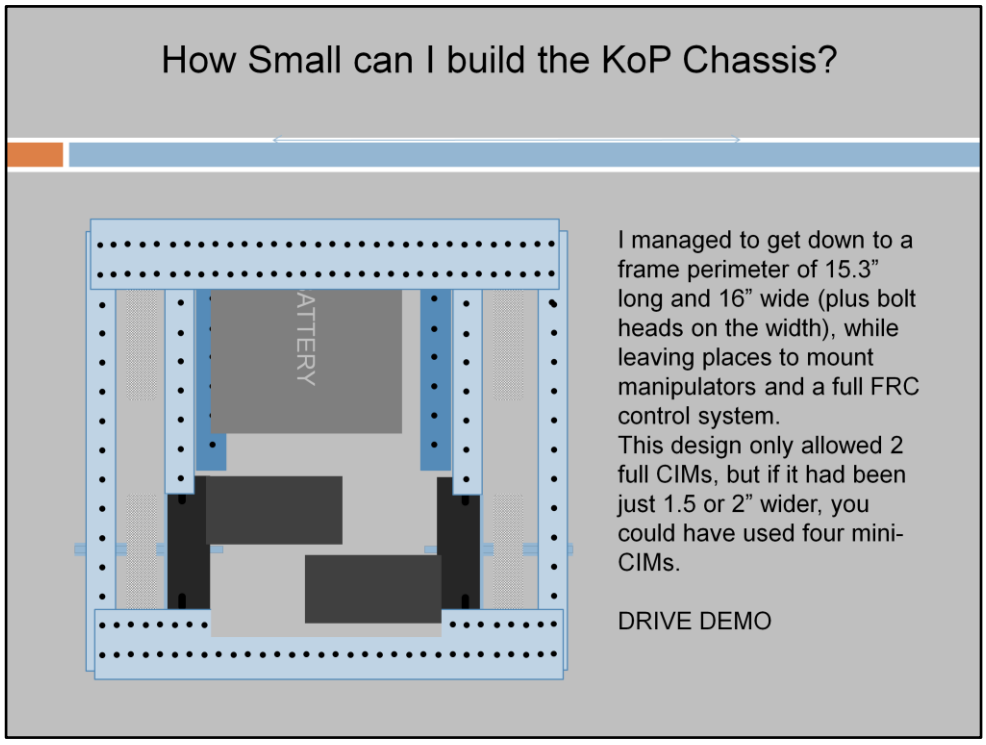
- Mecanum wheel kit (includes gearboxes)
- 3-CIM EVO slim gearboxes
- 4-Redline EVO slim gearboxes (also achievable through DeCIMators)
- Shifting (EVO) gearboxes

# AM14U3 COTS Accessories

- Battery Mount Kit
- Mounting brackets for bumpers and just about anything else
- Short or Extra-long gearbox shafts
- Encoder kits (recommend SRX encoder kit and AndyMark's mounting kit for same, with SRX motors)
- Perforated polycarbonate belly pans
- AM Toughbox gearbox spacers (more later)

# Adding VF Manipulators to the KoP

- Drill 3/16” holes in the center plane of VersaFrame channel, likely 3” to 4” pieces.
- Use “rack clips” to mount to the inside or outside sheet of the KoP chassis.
- Consider the “close enough” (CE) values for 30, 45, 60, and even 22.5 degree angles.
  - 30-60-90: 4-7-8 is CE: (16 + 49 = 64 +1)
  - 45-45-90: 12-12-17 is CE: (144+144 = 289 -1)
  - 22.5°: 5-12-13 is CE: (tan-1(5/12) = 22.62°




In order to use the chassis this small competitively, you may wish to access the battery from below rather than above.

his chassis could be used for a gear runner in 2017, or a vault/switch bot in 2018. In both cases, I would recommend going a bit wider to get in four motors; this would also enable use of the battery mount kit.

# Questions and Discussion!

Ice breaker questions – do not limit to any specific year.

- How did your team use the KoP chassis?
- Why did your team NOT use the KoP chassis?
- How did your team misuse the KoP chassis?
- What chassis issues did your team have?