

GETTING STARTED WITH – & MAKING THE MOST OF – THE KIT OF PARTS (KOP) CHASSIS

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Who do we have here today?

- Do we have any rookie teams here, or teams who have lost most or all of their chassis experience?
- Other end: who has a CNC mill/router, or lathe, mill, and/or router with one or more experienced operators?
- Who's team has experience building robots, but is limited to a drill press or hand drill and a hack/chop/band saw for cutting?
- Other: please describe

Why use a Kit Chassis?

- ▣ There are only 45.562 days from kickoff to bag. You have to break down the game, make a strategy, design a robot, build it, refine what doesn't work, and do some drive practice before bagging it.
- ▣ The drive chassis must be dependable; without it, you can't do much of anything useful in most FRC games.
- ▣ The purpose of the drive train 90+% of the time is simply to get you from point a to b
- ▣ **Do you need to re-invent wheels?**
- ▣ Any time saved on drive system design can be used to design and build manipulators, or do drive practice. A great driver with a fair robot can usually beat a fair driver with a great robot.

A Great Way to Build Two Robots

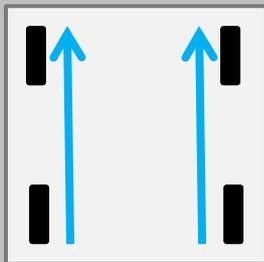
- Building two robots is a great way to work around the Bag Day limitations – get more iteration time, get more drive time.
- Using Kit robots is a great way to make both chassis the same.
- Using VersaFrame is a great way to make the manipulators the same (more later)
- 3946 has bought two “frame only”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

What Kit Chassis are available?

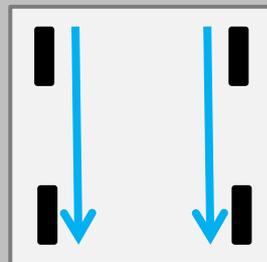
- [FRC Blog]: The 2019 Drive Base Kit.
 - It's similar to the [AM14U3 from 2018](#), and includes a bumper and battery mounting kit.
- AM14U3 (no batt/bumper) is available at AndyMark for \$656
- AM14U3 Square Edition: 4" wheels, 8.45:1, four belts, \$438.
- The AM14U3 frame parts plus bearings: ~\$200. 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.

How do you steer these robots?

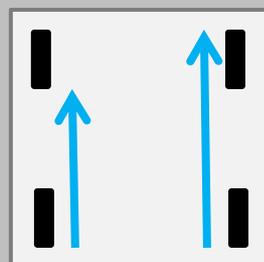
- Except for the mecanum option, steering is via a “skid-steer” or more colloquially “tank drive” or (recently) “differential drive” steering.
- All the left wheels are on one drive train, synchronized by belt or chain, and all the right wheels are on another equivalent drive train.
- Steer by moving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



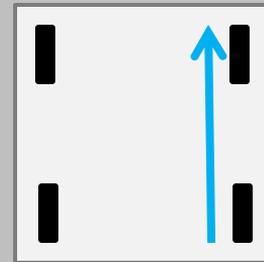
Forward



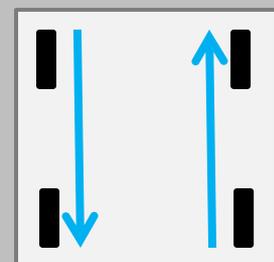
Reverse



Slight Left

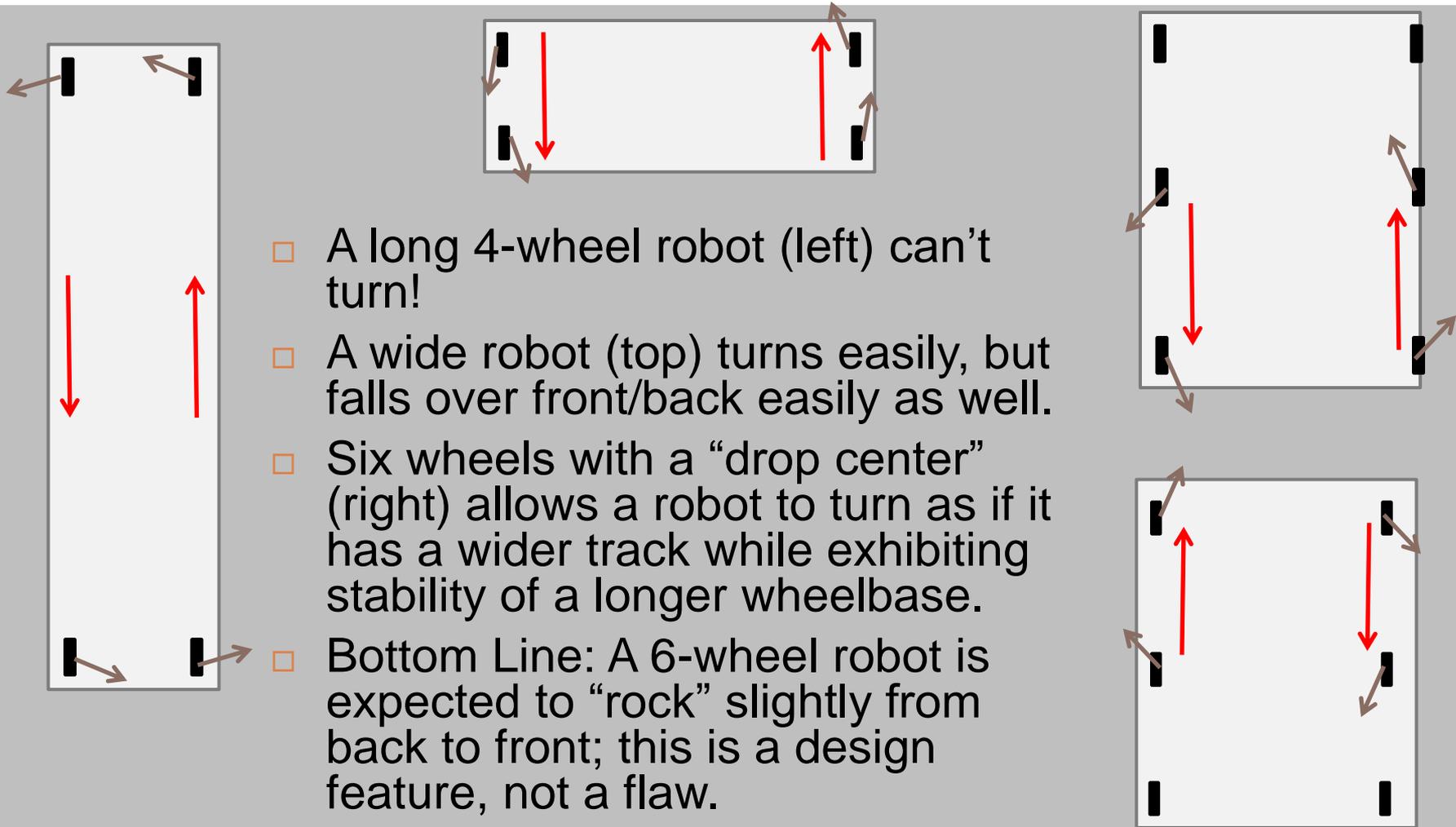


Hard Left



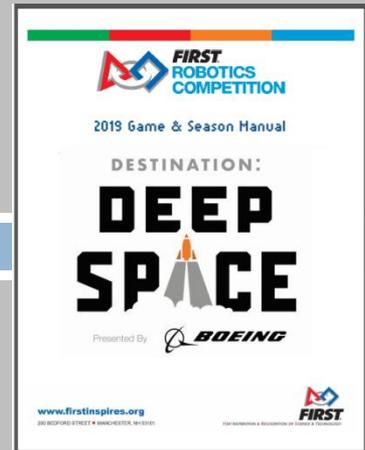
Pivot Left

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.

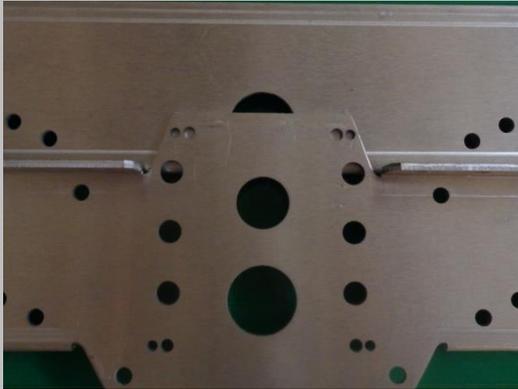
Before Assembly



□ RTM (Read The Manual)!

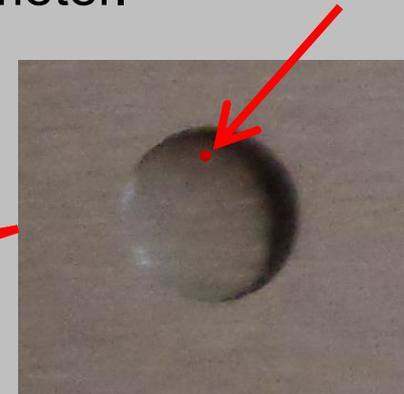
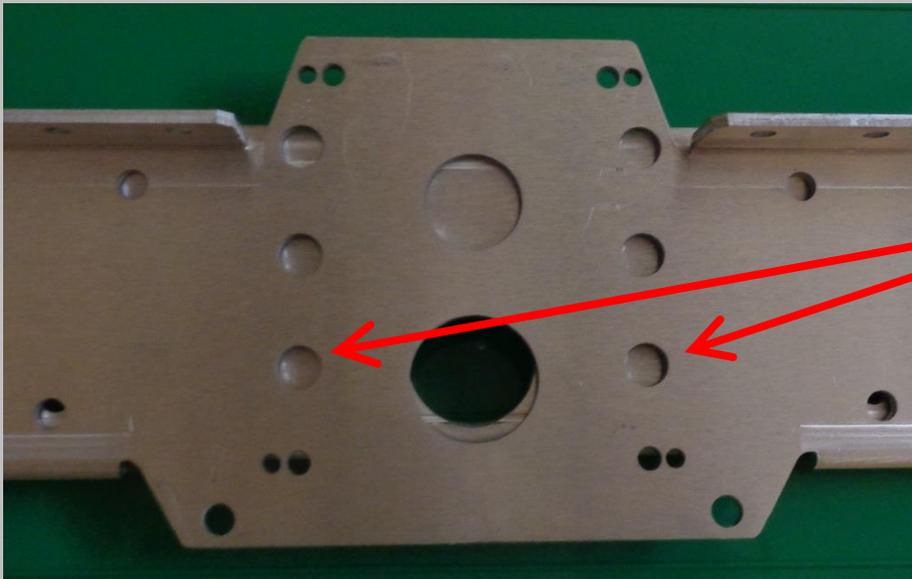
1. Select chassis size*, gearing, wheel size and placement based on the game and your strategy (see COTS and non-COTS options later).
2. Order any needed parts
3. Mark the frame cuts, including long churros.
4. Do a “mock assembly” to ensure things line up
5. Cut the frame members as needed
6. (optional)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

Tip: Motor Replacement Access Holes



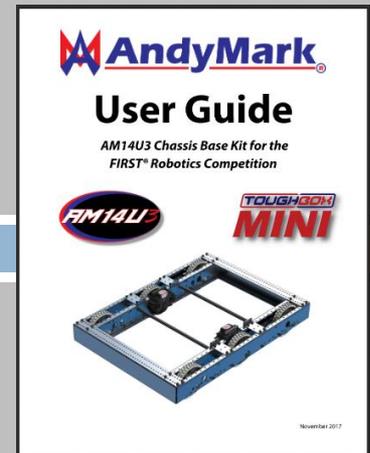
Place outer sheet on table, outer side up. Place inner sheet above, inner side up, slide up and center (line up both ends)

Mark holes $1/8$ " above center, or $1/16$ " below top center of indicated holes. Drill pilots then enlarge to $3/8$ " in diameter.



The replacement process is in the speaker notes.

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!
- Gearbox Assembly *****:
 - Install gears bosses-to-bearings! Flat gear sides rub the bearings. Skip step 8 (grease) until after step 13 (motors)
 - After motors (step 13): Run motors ~20 minutes with no grease and no load (stop if funny noises!). Disassemble, clean, grease, and reassemble gearboxes before continuing. This breaks in the gears properly.

Key Items and Tricks for Assembly, cont.

Frame Assembly:

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

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 \geq \$400

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

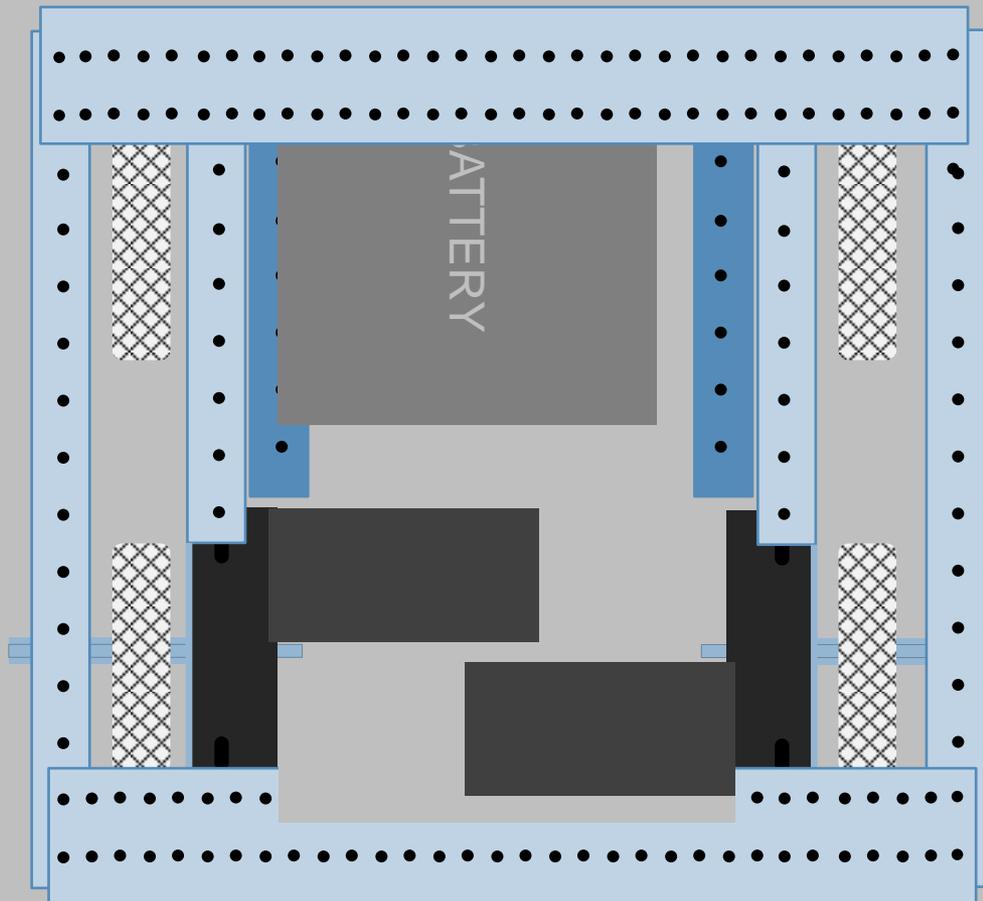
AM14U3 COTS Accessories

- 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: $(\tan^{-1}(5/12) = 22.62^\circ)$

How Small can I build the KoP Chassis?



I managed to get down to a frame perimeter of 15.3" long and 16" wide (plus bolt heads on the width), while leaving places to mount manipulators and a full FRC control system. This design only allowed 2 full CIMs, but I'm pretty sure that you could have used four mini-CIMs.

DRIVE DEMO

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?