Interview Questions and Answers from Customers 9/7/2017
Customers: Leanne Cushing and Mike Jeffries

1) What are common concerns related to meltybrain style robots?
LC: It getting out of control, confused what direction you're driving, centripetal force for internal components
MJ: Spin up time, reliable translation, and translation speed are the main issues I've seen.

2) What did successful meltybrains do right?
LC: I've only seen meltybrain bots in ant and beetle weights. Their simplicity helps. Having removable teeth for the outside (assuming you're going with a circular shape) is also good--- easy to change out if it takes any damage.
MJ: Minimizing shock on vital components, reliable navigation method, and easy means of seeing what the navigation reference is (latter irrelevant if autonomous)

3) What did unsuccessful meltybrains do wrong?
LC: Thin material walls, messy internals, wrong rubber hardness
MJ: Interference prone navigation, slow spin-up, no shock mitigation for vital components

4) optimal rotation speed? Typical kinetic energy stored by rotating weapons?
LC: I'm not sure! Usually the robots will just… go. Loads of hobby roboticists aren't engineers so they don't do that much planning. I would assume a good methodology would be to calculate the optimum centripetal force to throw a similar weight robot a few feet away-- if they have sticky wheels, it'll just be damage.
MJ: Ideal speed will depend on translation speed, opponent speed, and desired behavior upon impact. Lower revolution speed means larger bite but less KE stored. High powered spinners in the 30lb class tend to run somewhere between 5-10kJ stored. As a point of reference Bombshell spun a ~50lb disk and was storing approximately 25kJ which was sufficient for the 250lb class.

5) What robots are our biggest challenges? why?
LC: Vertical spinners are just a pain for most people--- they also put you at risk of not being able to self-right. I guess the same would go for horizontal spinners and lifters.
MJ: Wedges will be the largest threat when at speed, vertical spinners will be the largest threat when not at speed because they'll deliver high energy hits off axis from the main forces the bot will be designed to deal with.

6) Ideal construction materials per price?
LC: Our 30lb robot that my team is currently building has a BOM cost of around $2000 and we're doing all of the machining and waterjetting ourselves--- my teammates are also Formlabs/Markforged employees so we get all aesthetic/top armor paid for.
MJ: A few routes seem plausible:

UHMW or similar main frame with well anchored tool steel teeth/an outer hard ring of material to anchor teeth in place
Aluminum main chassis with steel teeth
One of the best meltybrain style bots I've seen are the spinning tortoise (http://www.buildersdb.com/botpics/8175.jpg) family of bots that use the latter configuration. Later revisions of the bots used a billet aluminum chassis for the majority of the structure to reduce shear loading on hardware.

7) Prebuilt vs design your own communication? What is typical? which is cheaper? reliability? which is best for application?
LC: Prebuilt is definitely more reliable for me. If you have someone with decent firmware knowledge, you could go that route. Our heavyweight at Robogames had some communication problems before our match against Sewer Snake (Stinger with a different paint job) due to the custom controls we had decided to test and therefore we had to forfeit. Custom has the opportunity to give you more realtime data during a match as well as more switch/controller options. The cost if you consider the amount of time you need to invest (if going custom) is probably about the same. Personally, I would rather go with a tried and true option with ratings and a plethora of resources if things aren't working quite right.
MJ: I'd lean off the shelf to the extent that it's practical as that will minimize troubleshooting of issues that aren't directly related to the design goals.

8) Are composite materials an option?
LC: Definitely. Markforged has been great to see how kevlar and carbon fiber reinforcement helps--- their Onyx is also great.
MJ: I wouldn't ignore composites but I'd carefully look at the expected loading and make sure that you're getting the best out of the materials.

9) should there be shock absorption from armour to innards? How is that typically implemented?
LC: ALL OF THE WUBS. Definitely worth having but you can go the Hal Rucker method of just a thick wall as well. Since working closely with Charles, I've become a fan of the sandwich mounts on McMaster.
MJ: Some means of absorbing shock would be a good idea. Exact methodology will depend on chassis design but I'd suggest extensive padding of battery/electronics areas and mounting the motor/gearbox/wheel in a fashion where it has some flex under extreme loading.

10) Width of wheelbase?
LC: So I'd leave 1-2" from the outer armor on either side. I think I'd keep the wheelbase distance variable for the moment--- most 30lb robots that the Boston folks make have a wheelbase distance of 12-16"
MJ: A narrow wheelbase will allow a faster spin rate for a given gearing which means the bot will likely be able to maneuver when not spinning if necessary. Given that the planned bot is 30lbs, 8-12" width is probably somewhere in the ballpark.

11) wheel design? Material Choices? Grip? Slide?
LC: I've become a big fan of the Banebots wheels for my robots--- they come in a variety of hardnesses. If you have access to 3D printers, you could play with casting your own.
MJ: You'll want to select wheels for durability and wear resistance. I'd at least strongly consider Colson caster wheels or similar, though you may end up making metal hubs and casting a urethane tread onto them. To minimize side forces when spinning you'll likely want to keep the wheels reasonably narrow.

11) Location of accelerometer?
MJ: In general I'd expect the further from the center of rotation the better information you'll get from it, but there will likely be a limit to how far out it can be based on the energy it'll see on a sudden stop.

12) Magnetometer Effect of motors?
MJ: I can see the motors causing havoc on the magnetometer. Isolating the magnetometer from the motors to what extent is practical and doing some testing/calibration where possible could be a means of mitigating some of these issues.

13) Thoughts on absolute magnetic/ directional reference?
MJ: There's significant risk that the bot itself may interfere with using magnetic references for directional control so this would be a system to prototype early and identify any issues/mitigation methods that can help.

14) 2 way or 1 way comms?
LC: One way is mainly what we've done.
MJ: Unless you've got a means of using the information sent back from the bot to improve the transmissions in the other direction it's likely a waste of effort. On-board data logging would likely be a more practical way to get data on what's happening.

15) How often are the electronics destroyed? how do teams handle damage to electronics?
LC: ESCs burn out if you don't pick the right ones, LiPos can get puffy or warm, I've had bad luck with OrangeRX's as well. If you use a Ragebridge, Charles takes all failures back and replaces them with new ones. I. Love. Bullet. Connectors. They make switching out damages/dead electronics a lot easier. Highly recommend.
MJ: Electronics damage is somewhat rare in most bot types, however meltybrain spinners are one of the designs that's most prone to electronics failures. The only real mitigation techniques are mounting to minimize loading on fragile components and having spares to replace anything that is damaged.

16) how often do connections come loose? how do teams prevent this?

LC: I've seen cables connecting the power being cut from weapons if they stick out of the frame at all. Something as simple as a duct tape works.
MJ: Individual techniques vary widely, however if I'm worried about a connector coming loose I'll usually give it a quick wrap of electrical tape. This seems to do enough to absorb momentary shocks while still being reasonably quick to remove when needed.

17) common failure modes and solutions?
LC: I haven't seen just an outright failure.
MJ: For melty bots the most common failures I've seen are
Getting high centered either due to minimal ground clearance to begin with or extensive tread wear.
Electronics/motors failing due to shock on impact.
Bot unable to reach dangerous speed due to slow spinup.

With the wheels it's about picking the right tread material and being able to replace them quickly as needed. If it's difficult to replace the wheels it will be tempting to try to get an extra match or two out of well worn wheels.
For the shock failures it's about mounting all the components in such a way that their mounts help absorb shock and controlling the axis the shock travels through to minimize torque on things like board components or motor parts.
Getting up to speed is all down to sizing the components right and having some degree of agility when not spinning/during spin up. The other bot will be trying to stop the spin-up so getting to speed quickly or being able to dodge to at least some extent while spinning up will be a huge help.

18) is radio signal reliability a common issue?
LC: Make sure you have your receiver not in metal causing a kind of faraday cage.
MJ: Most commercial 2.4ghz systems have been very reliable once you're past dead on arrival components.

19) how do teams usually handle the manual killswitch?
LC: Whyachi switches are my personally preferred method. The Georgia Tech guys use custom connectors.
MJ: A switch or removable link that's easily accessed without directly putting your hand/limb in the spin path is common. For a melty bot one thing that might be worth looking at is a small stand that one end of the robot rests on during power up so the wheels aren't in contact with the ground during power on. I tend to use the Whyachi MS-05 in my 30lb bots, though a deans based removable link or similar would likely be sufficient.

20) typical battery voltage and capacity?
LC: I think this will vary significantly depending on how you have your drive setup. Off the top of my head, 6S seems likely.

MJ: 6s lipo is fairly common in the 30lb class. For my 30lb robots I run a 2650mAh pack. I'd expect the meltybrain bot would need more than that though the exact value will be down to motor selection and gearing. You may find that the peak current of the motors drive capacity more than expected use in a single fight as you'll want the battery to be able to source enough power for your motors.

21) typical choices in motors?

LC: Brushed: The go-to for 12lb and 30lb lately have been the Banebots P60 gearboxes with the 300 series motors.

Brushless: The Dewuts are used often in Boston too (Equals Zero Design makes them--- they're basically just Hobbyking drill motors). Larger rotor motors could be useful for 4WD if you want to be brushless--- Overhaul was brushless and I forget if Hypershock was as well. I know the debugging for brushless can be tricky on larger bots.

MJ: I'd start at brushless inrunners as they've got a relatively low inertia rotor when compared to brushed or brushless outrunner motors. You'll likely want to reinforce and support the motors and motor components well.

22) backup UC? Backup Comms?

LC: Nope to both and I can't recall seeing redundant comms--- might cause too much interference.

MJ: Very rarely have I seen backup systems be worth the effort as it's often the case that you'd have been better off using the weight/time/money involved in the backup system on making the rest of the bot stronger or more reliable.