Mark4 printer todo list – As of 11/1/2021

1. ~~Fab Aluminum top plate and print bed.~~ Done
2. Fab heated bed. Done
   1. ~~Define magnet holes – locations and depths.~~ Done. 36 pockets that can handle a magnet up to .5" diameter, and cut to a depth to leave 2mm of aluminum between the magnet and the top of the heated bed.
   2. Define spring fastenings or other keepers are each kinematic ball location. Done. Threaded hole for spring near each kinematic seat.
   3. ~~Mounting features for heater cable and thermistor cable.~~ Done.
   4. ~~Define redundant thermal overrun protection (thermistor location and any required grooves for cable).~~ Done. Thermal cutoff switch mounting added. Need to select cutout temperature.
   5. ~~Build final print-bed side of bed kinematic supports.~~ Done
3. Prep heated bed.
   1. ~~Install kinematic seats on bottom of bed plate.~~
   2. Test 3/8" SmCo magnets.
      1. ~~Make 36 13.5mm diameter disks, ~4mm thick to user as spacers below the magnets. Done. Made 3.2mm thick.~~ Done
      2. ~~Place one magnet in the bottom of each hole, followed by a spacer and a piece of blue tape.~~
      3. ~~Test hold of steel build plate~~. Done
      4. Decide if we need to switch to ½" diameter magnets. – 3/8" magnets seems good enough.
      5. After step 4b(ii): Blue-tape bed heater to bottom of bed and plan wiring for thermal cutoff and bed heater.
      6. Decide whether or not to use a cable chain to manage the power and thermistor wires going to the bed heater.
      7. Buy aluminum spacers from sendcutsend to replace the wood plugs. ~~Done~~. May add 1mm laser cut Delrin spacer on that.
      8. ~~Buy ½" magnets if needed.~~ Done. Not needed.
      9. Assemble heated bed with magnets, aluminum spacers, and really using the adhesive of the heater. No turning back after this.
4. Replace wood top plate with Aluminum.
   1. Before stripping anything down:
      1. ~~Run bed leveling and bed mesh compensation measurement on the wood heated bed. and save the resulting file. This is to use as a baseline for future measurements.~~ Done
      2. ~~Put the aluminum heated bed on and repeat bed leveling and mesh compensation measurement.~~ Done
   2. Transfer process.
      1. ~~Remove belt from prototype.~~ Done
      2. ~~Remove pulleys and standoffs, making sure to provide stops to prevent the Y rails from running off their tracks.~~ Done
      3. ~~Lubricate all pulley ball bearings with WD40 and ensure they are spinning freely. Clean any grease and accumulated crud from the surface the belt rides on.~~ Done.
      4. ~~Assemble pulleys on aluminum top plate using the new aluminum standoffs.~~ Done
      5. ~~Remove bridge from y rails~~. Done
      6. Remove, clean, and replace the ball bearing pulleys on the bridge. Mostly done. Need to clean pulleys of accumulated grease and gunk.
      7. ~~Remove carriage from bridge and carefully remove the sliding block from the rail. It might be easiest to remove the rail from the bridge.~~ Done
      8. Check that all ball bearings are in the sliding block and replace it on the rail. Check that the block slides freely on the rail. Reinstall the rail on the bridge if it was removed. Be sure to put keepers on the rail to prevent the block from sliding off.
      9. Remove the Y rails and check their bearings the same way the X rail was checked. Note that the ball bearings for the Y rail are larger than those for the X rail Do not use X rail balls in the Y rails.
      10. Install the Y rails on the new top plate with approx every third screw. Tighten only the screws on the left side rail. Install the stop-blocks on behind the Y rails using locktite on the screws.
      11. Install the bridge between the rails, using a framing square to ensure the X and left Y rails are perpendicular. Before tightening the screws.
      12. Use the rail and Y blocks as a spacer to get the right Y rail perfectly aligned before tightening the screws in the right Y rail. The bridge should slide easily with no sticky spots. It might be necessary to loosen the screws on the left Y rail to get things "perfect".
      13. ~~Remove the Motors and any remaining HW from the wood proto top plate.~~ Done
      14. ~~Remove the wood top plate and replace it with the aluminum top plate.~~ Done
      15. ~~Install the motors and other hardware.~~ Done
      16. One by one, remove the screws holding the bride to the Y blocks and reinsert using locktite.
      17. Recheck the spacing on the Y rails. If it's good, add remaining screws using locktite, then recheck the spacing and make adjustments if necessary. Remove the initial screws and reinsert them using locktite.
      18. Install the carriage on the bridge, using locktite on the screws.
      19. Install the belts. Be sure to use the new aluminum belt keepers.
      20. Tension the belt.
      21. Power up and run some tests.
5. Cable management concept from dock to tool. Be sure to enable multiple docked tools and one mounted tool.
   1. Define /prototype tool parking concept. Done. Parking plates designed. Need to cut and thread parking posts.
   2. Finalize cable management structure (rainbow material) that can reach to all corners of the build plate when attached to the tool, and not interfere with others on tools that are docked.
   3. Decide how cables get from controller to dock-end of cable management structure. Maybe holes through the top plate near each tool dock. Done. Cables route over the rear edge of the top plate. A 2020 extrusion is screwed to the bottom to provide a mounting point for the end of the rainbow.
6. Define Cable management concept from control board to dock
   1. Define control board mounting. Replace prototype plywood board with "something", ideally cuttable on Big Red. Options:
      1. FR4 (aka garolite) – not lasercuttable? But maybe can be marked with the laser for hole locations?
      2. Acrylic – not ideal because it might get too warm and is brittle.
      3. Aluminum sheet?
   2. Be sure to add standoffs between boards and the board.
   3. Define interface connection for all cables

1. Fab aluminum bottom plate
   1. Get some nylon footed leveling feet for the base.
   2. Do we really need the base plate to be made from aluminum? What does Al do for us that the current MDF does not?
2. Complete enclosure design
3. Document setup and calibration procedures
   1. HW assembly, particularly Z-axis components.
   2. Belt tensioning procedure
   3. Define and create any needed HW setup gages.
   4. As-built documentation
   5. SW parameters – z-offsets, dive-heights, other user parameters in the gcode file
4. Optimize Z-axis limit switch mount HW and location
   1. Move home switch position to top of Z axis. Will require combining this function into the z-probe.
   2. Need to prove the inductive switch will work with an aluminum plate so.
   3. Can we also put in a safety limit switch on the bottom of the rail to work as a backup to prevent over-lowering?
5. Investigate wobble and squeak of Z-Axis acme shafts – they wobble and make noise.
   1. Is there enough force to wobble the build pate?
   2. Add Nylon bearing to top end of shaft.
   3. Can we straighten out any slight bends.
   4. Replace one Z-Axis shaft coupler that failed. Maybe switch to a more flexible coupler.
   5. Redrill motor mount holes on Z axis motors to allow some motor movement.
   6. Investigate swapping R/L brackets that hold the Ball side of the Kinematic mounts. Might allow moving the rails and motors up so motors cam be installed without removing the base plate. 6/9 – Investigation complete – decided not to pursue. Moving motor mounts up 12mm will make it so we can get the motors out. Of their mounts without the need to remove base plate.
6. Define the tool lock/unlock motor assembly
   1. Buy parts to allow duplication of the Jubilee lock morot – tensioning cable, springs, limit switches, etc. ,
   2. Motor position
   3. Acquire/print/assembly parts
7. Build a "real Jubilee" tool using the mosquito hot end we bought for the project. Done
   1. Current tool is prototype.
   2. Water cooled print head ala Mark McComsey – NOT YET.
8. Add an "estop" switch on the printer for user immediate shutoff.
   1. Pick an unused IO port on the duet. See GCode M581 for setting up a trigger. <https://duet3d.dozuki.com/Wiki/M581>
9. Decide on "production" use model for printing and maintenance
   1. If Panel Du, acquire one and figure out where it attaches to the machine
   2. If web-control, need to figure out the controller (Rpi zero?), plus keyboard, mouse, etc.
   3. Our Duet board is wireless. We need to get the wireless in the studio to be robust, rework the Duet board to become wired, or replace the Duet with a wired-LAN version.
10. Before reassembly
    1. Verify all rail blocks have a full complement of bearings
    2. Make alignment tools for assembly (laser cuttable when possible)
       1. Z motor mounts – z direction.
       2. Z- side rail #1 – perpendicular to top plate and centered on 4080 slot.
       3. Z-side rail #2 – parallel to rail #1 (link blocks together)
       4. S-back rail – perpendicular to top plate.
       5. Zrails vertical
       6. Y rails- parallel to each other (link blocks together with bridge)
11. After assembly with the new top and bottom plates, and heated bed
    1. Complete alignment of print bed/ nozzle/ probe.
12. Add LED lights and camera?
13. Additional sw work
    1. Define, inherit macro for tool docking
    2. Z-axis homing – move down or up?
    3. Investigate Duet "input shaping" (M593) to reduce/eliminate ghosting at higher speeds. https://duet3d.dozuki.com/Wiki/Input\_shaping
    4. Investigate Duet "Pressure Advance" <https://duet3d.dozuki.com/Wiki/Pressure_advance>