The Broncobots Torq-Cut 22 Restoration

Fall 2017

Through a fellow mentor, the team had a connection to the Brunson Instrument Company who very generously donated our newest machine, a 1996 vintage Bridgeport Torq-Cut 22 VMC. This paper is our way of showcasing the work that we put in to breathe new life into this old production machine prior to the robotics team using it.

In late August, after nearly 6 months of waiting, we were given the green light to move the machine out of the caves that are home to Bruson Instruments. Since rigging companies are expensive, we originally thought we would transport the machine ourselves with a pickup and trailer; however, weighing in at 6500lbs, plus the forklift that would would be necessary to load the machine, we decided it easiest and safest to hire a semi that could haul both together. We got the the logistics figured out and set the move date to be September 15th, 2017.

The day came and several Broncobot mentors met up at Brunson. We rented a forklift from a nearby company, moved the machine outside, and loaded it onto the landoll trailer.

Some backstory on this machine - It was made about 1996, Brunson purchased it new, and it was used in a production environment in various capacities up until about 2015 to machine stainless steel. As best as we can tell, when it was removed from production it was simply unplugged and placed in a corner - the machine was left with all the coolant and stainless shavings covering every visible surface inside the cabinet. I didn't take nearly enough "before" pictures to capture the condition it was in… just know that it was disgusting.

Due to a parade at the high school, and so we would have daylight, we left the machine on the truck overnight and met to move it into our robotics shop the following day, a Saturday morning.


TOYOTA
SPECIALIZED TRANSPORT


Bridgeport
22

Once it was in the shop myself and other mentor, Joshua (jgwentworth96), took lead to make this machine ours over the coming months. We knew we wanted to paint some parts of it, especially after seeing the old paint falling away and some surface rust, but we found that it was going to take a lot more than just some paint. The day we set it in the shop I used a combination of putty knives, an electric power washer, and rags to

start to clean things out. We very quickly determined that this wasn't going to be enough. There were chips in every crevice, a green algae of sorts had made a home in the upper portion of the cabinet... it was bad.

If we were going to do this, we had to go all out and do it right, so we determined that the enclosure had to come off.

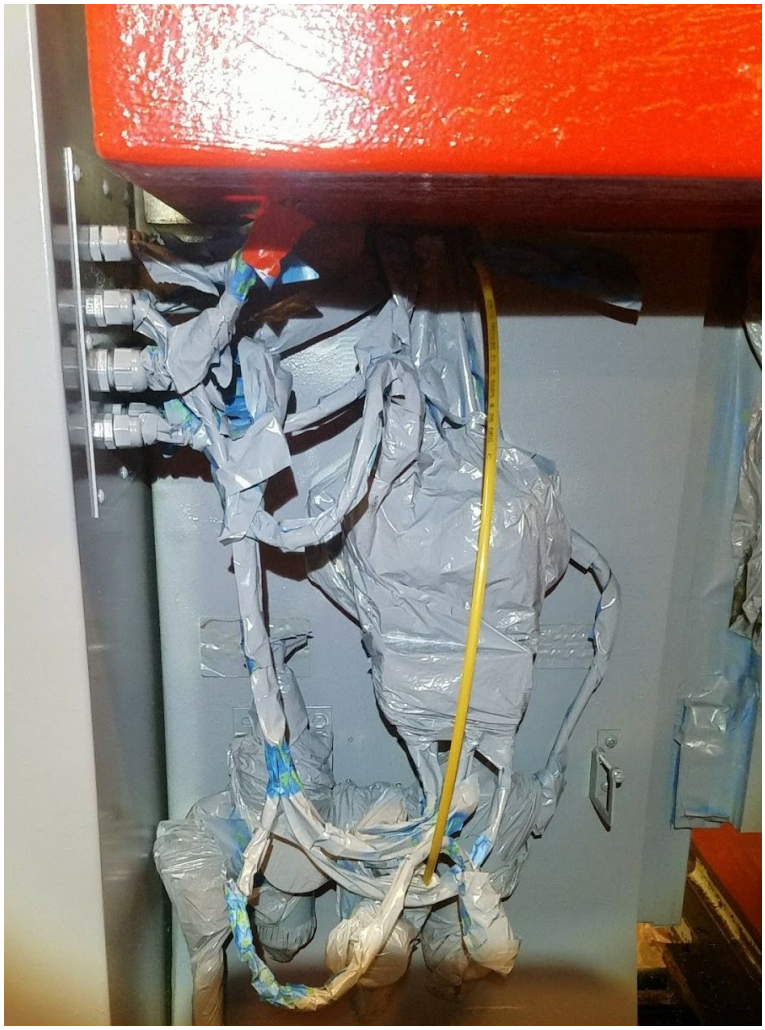
Due to schedules, Joshua and I could only work on this on weekends, and since we still had regular team meetings throughout the week we had to clean up most of our mess at the end of every weekend.

The next weekend, with the help of a few friends and a Dingo we separated the enclosure from the machine, took it outside, and went crazy with a high power gas pressure washer. We washed every surface we could, trying to get years of chips and grime out of the machine as best as we could.

Once we had power washed the enclosure and the panels we brought everything back inside and started sanding all the parts to prep for primer. After we were sufficiently happy with the metal we set up our "paint booth" for the first time. We knew from the start that we wanted to paint the interior of the cabinet white to reflect as much light as possible, and on the outside we wanted to do grey and red in some fashion. For those curious, we used Rustoleum enamel paints for the white and red. Rustoleum enamels are premixed, and we didn't like their grey's, for that we used an outdoor enamel paint and mixed up the grey from the Broncobots team logo. About 90% of all of the painting was airless, hence the need for an enclosed booth, with some painting being done with an HVLP, brush, and spray paint.

The airless sprayer, while a major pain to clean on its own, with oil based paints was awful. Of course, that could have been because half the time I was cleaning it at 1am or 2am and just wanted to be done. Ultimately, the airless made easy work of getting in all of the crevices and getting a nice uniform coat on everything.

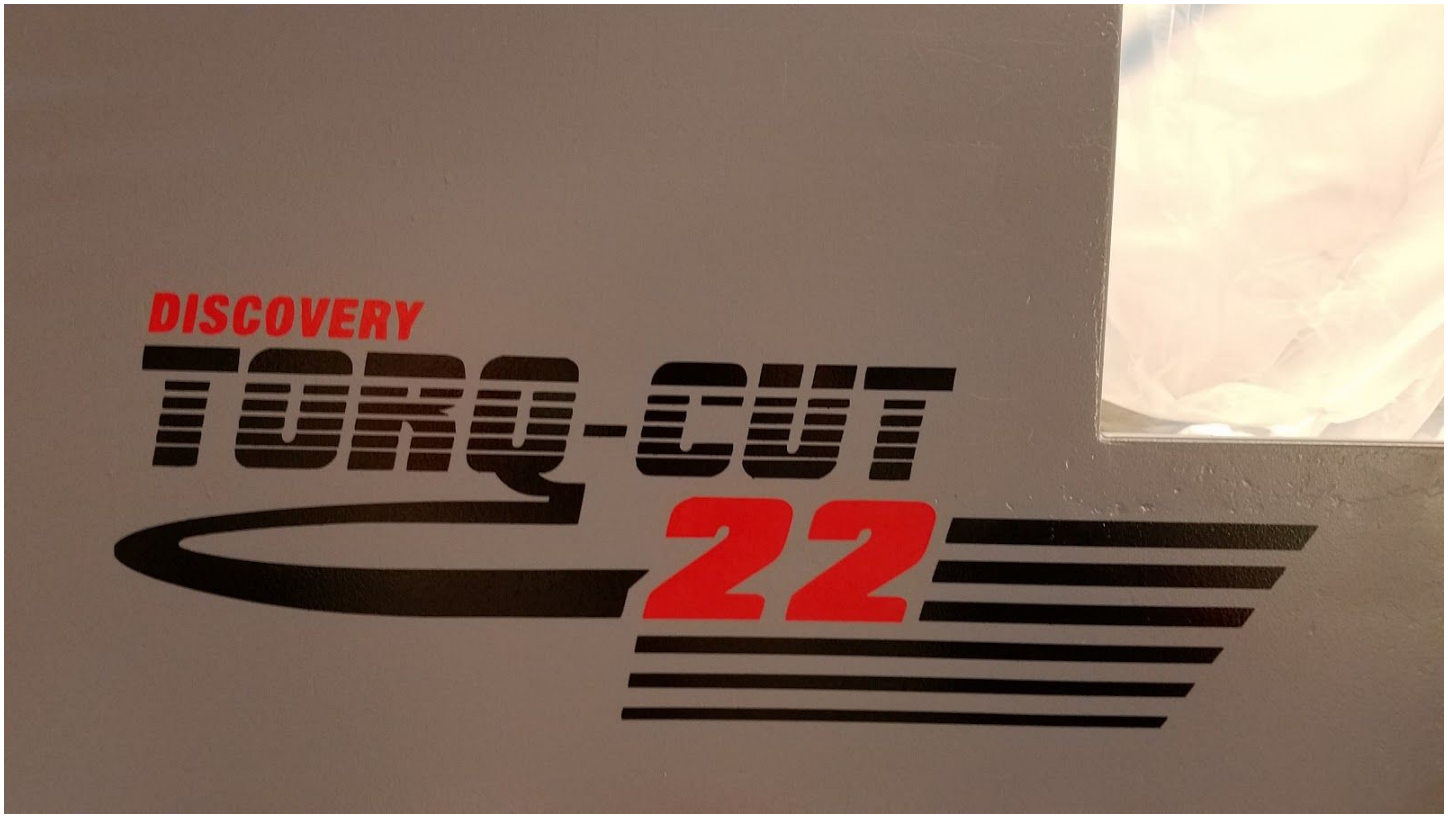
Having done the base coats on the enclosure and loose parts, we prepared to do some painting on the rest of the machine that we couldn't move. We decided that we would make all of the key moving/control components red: tool changer, table, spindle covers, boom arm, console; the casting, electrical cabinet, enclosure would be grey with a red accent stripe. For this we had to get creative and put up a paint booth back around the rest of the machine sitting in our shop.



Ideally we would have removed everything off of the casting, such as the air manifold - but we were advised to not mess with the old lines as that could quickly become more of a headache later. So I got to work taping them off and all the other components in/around the casting.

One of my personal goals for this project was to make the machine uniquely ours while maintaining its identity. By that I mean I wanted to have all of the original Bridgeport and Torq-Cut logos on the machine as they used to be. For that I used Fiverr.com, and for a very reasonable price, hired a graphic artist to recreate vector

versions of the original machine logos. Joshua had a friend with a vinyl cutter who then cut negatives of the logos out for us to use as paint stencils.



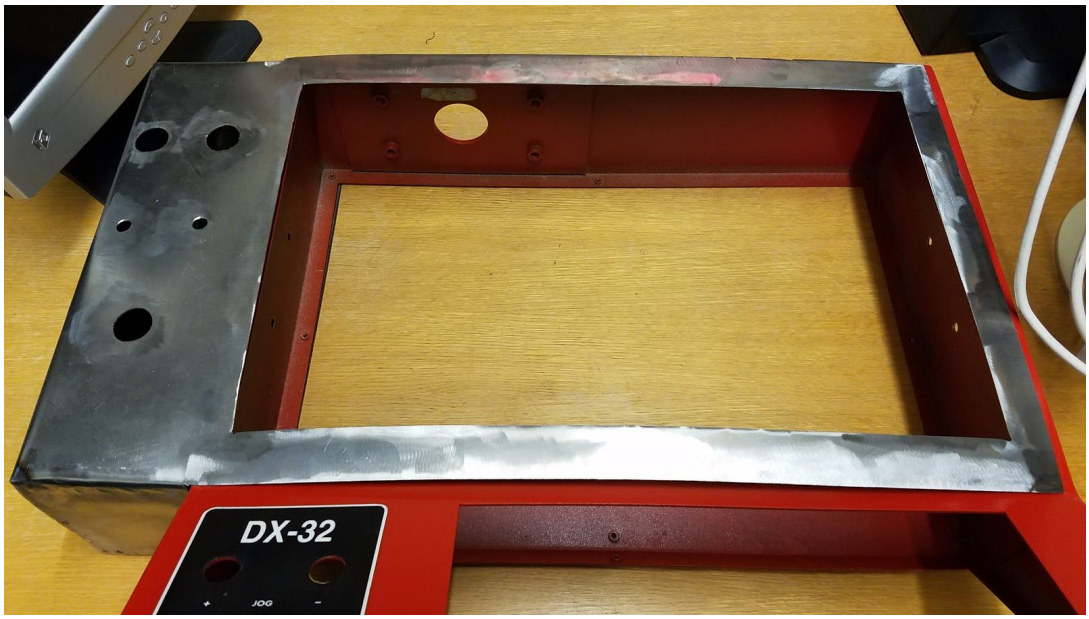
Part of the making it ours, aside from the colors, included adding the Broncobots logo underneath the console on the enclosure.

At this point, we had completed 95% of all of the painting. Since then, we touched up a few things up here and there.

There were some smaller tasks that we worked out - we purchased new ¼" polycarbonate for the side access doors and the main window, sourced a new rubber gasket to go around the window, replaced all of the bearings on the door, cleaned up the handles, and basically put the enclosure components back on. Shout out to Fairchild Industries for donating the new rubber gasket material for the window!

The largest "to do" item that we still had to address was the operator console. The 1996 CRT was very fuzzy, and looked… well, old school. We tested some of the random monitors we had laying around the shop.

Of those, we found that a wide-screen monitor would display okay, and one of them happened to fit inside the existing console perfectly. "Perfectly" in this case meant that it took up the entire console and left no room for the buttons. We then designed a new front panel that would shift all of the buttons off the side of the console giving us room for the new monitor in the old area. In the end we actually made this twice, the first time plasma cut the sheet metal, but some incorrect measurements and bad bends resulted in us trashing the first one. After getting the measurements correct, we decided to ask a local company, High Tech Laser and Polishing, to laser cut the next version.



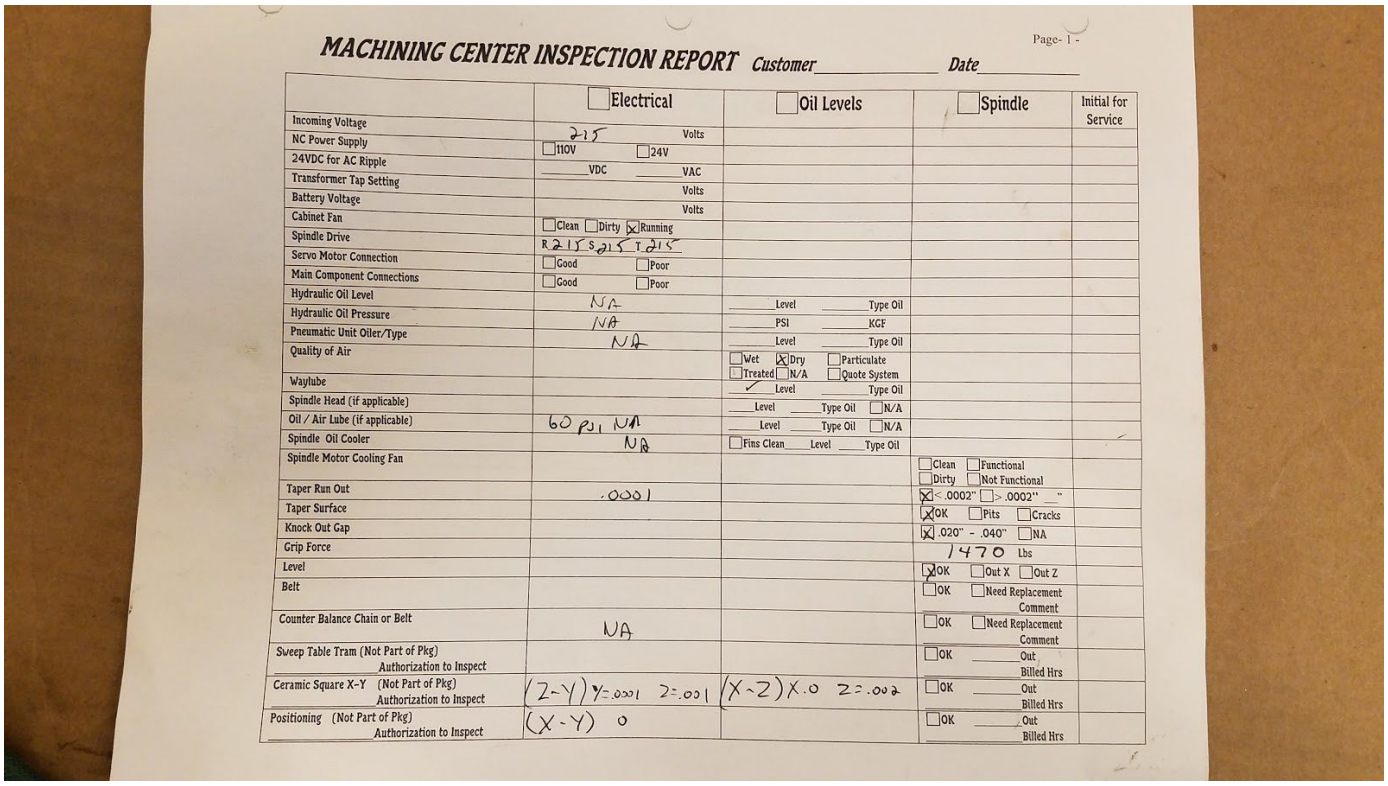
While Joshua had been CADing the sheet metal changes, I recreated the graphic that goes behind the buttons on the panel and a few other graphics to put back on the machine.

Once the console was completed, we took a break while waiting for the school district electricians to come and wire the machine (that process was started back when we got the machine in September and was finally done after Thanksgiving!).

Eventually, it was time to power it up for the first time in our shop. We opted to keep the enclosure off until we could could turn it on for the first time and run it through some basic checks. By doing this, everything would be easily accessible should we need to tear into any of it. There was some nervousness, but that was quickly put to rest, as we found everything was working just fine.

The next big thing was to get this thing properly set up. Joshua reached out to Maruka and was put into contact with Jim. Jim does CNC installs and repairs and said it would be no problem to come out and set things up for us.

Jim said that he was very impressed after he was done with the work. As you'll see from the sheets above, we had excellent squareness, almost no backlash, and little/no runout (more on this later), everything was spot on!



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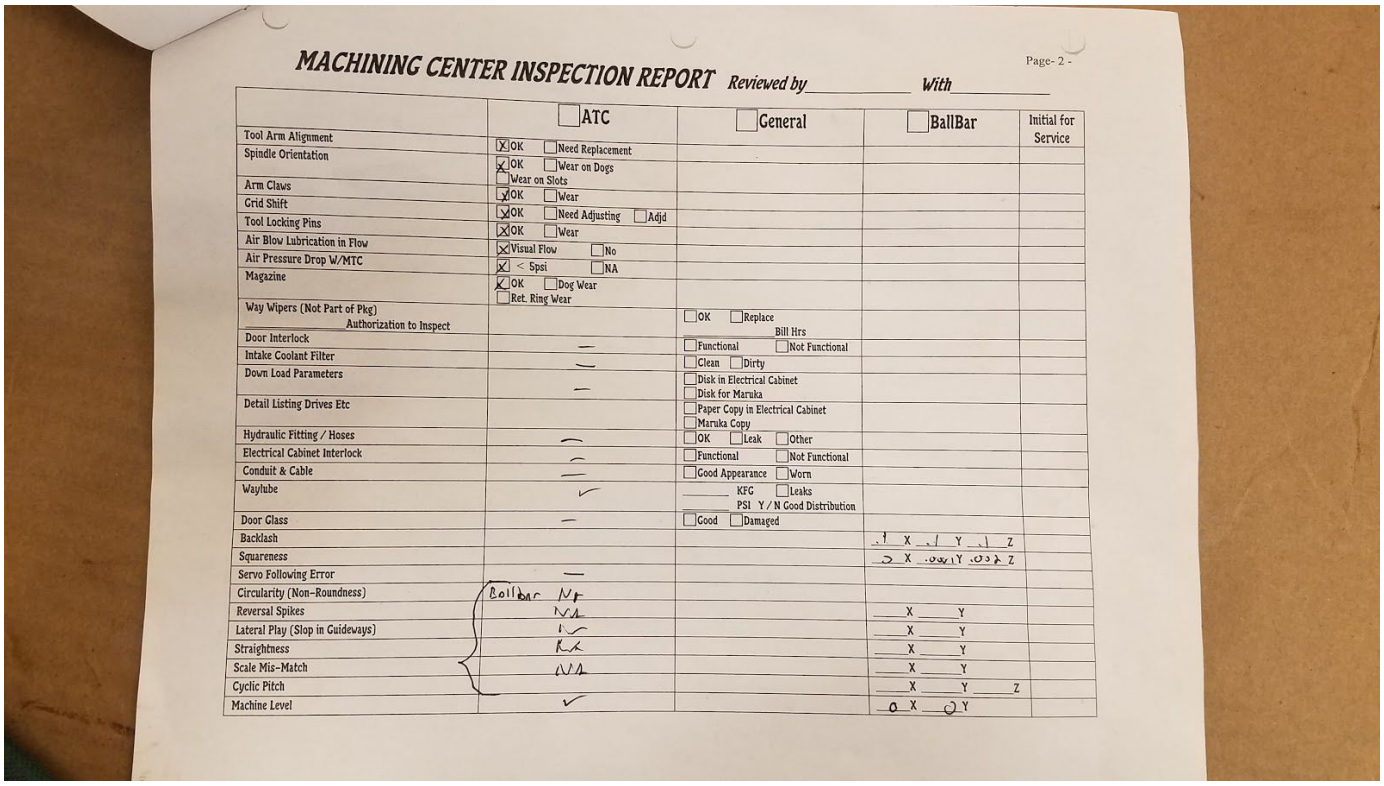
MACHINING CENTER INSPECTION REPORT Customer_____ Date_____

	☐ Electrical	☐ Oil Levels	☐ Spindle	Initial for Service
Incoming Voltage	215 Volts			
NC Power Supply	☐110V ☐24V			
24VDC for AC Ripple	_____VDC _____VAC			
Transformer Tap Setting	Volts			
Battery Voltage	Volts			
Cabinet Fan	☐Clean ☐Dirty ☒Running			
Spindle Drive	R215 S215 T215			
Servo Motor Connection	☐Good ☐Poor			
Main Component Connections	☐Good ☐Poor			
Hydraulic Oil Level	NA	_____Level _____Type Oil		
Hydraulic Oil Pressure	NA	_____PSI _____KGF		
Pneumatic Unit Oiler/Type	NA	_____Level _____Type Oil		
Quality of Air		☐Wet ☒Dry ☐Particulate ☐Treated ☐N/A ☐Quote System		
Waylube		✓ Level _____Type Oil		
Spindle Head (if applicable)		_____Level _____Type Oil ☐N/A		
Oil / Air Lube (if applicable)	60 PSI NA	_____Level _____Type Oil ☐N/A		
Spindle Oil Cooler	NA	☐Fins Clean _____Level _____Type Oil		
Spindle Motor Cooling Fan			☐Clean ☐Functional ☐Dirty ☐Not Functional	
Taper Run Out	.0001		☒ < .0002" ☐ > .0002" ___"	
Taper Surface			☒OK ☐Pits ☐Cracks	
Knock Out Gap			☒ .020" - .040" ☐NA	
Grip Force			1470 Lbs	
Level			☒OK ☐Out X ☐Out Z	
Belt			☐OK ☐Need Replacement Comment	
Counter Balance Chain or Belt	NA		☐OK ☐Need Replacement Comment	
Sweep Table Tram (Not Part of Pkg) _____Authorization to Inspect			☐OK _____Out _____Billed Hrs	
Ceramic Square X-Y (Not Part of Pkg) _____Authorization to Inspect	(Z-Y) Y=.0001 Z=.001	(X-Z) X.0 Z=.002	☐OK _____Out _____Billed Hrs	
Positioning (Not Part of Pkg) _____Authorization to Inspect	(X-Y) 0		☐OK _____Out _____Billed Hrs	



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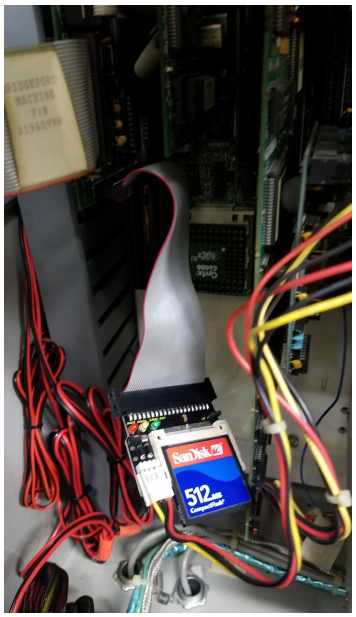
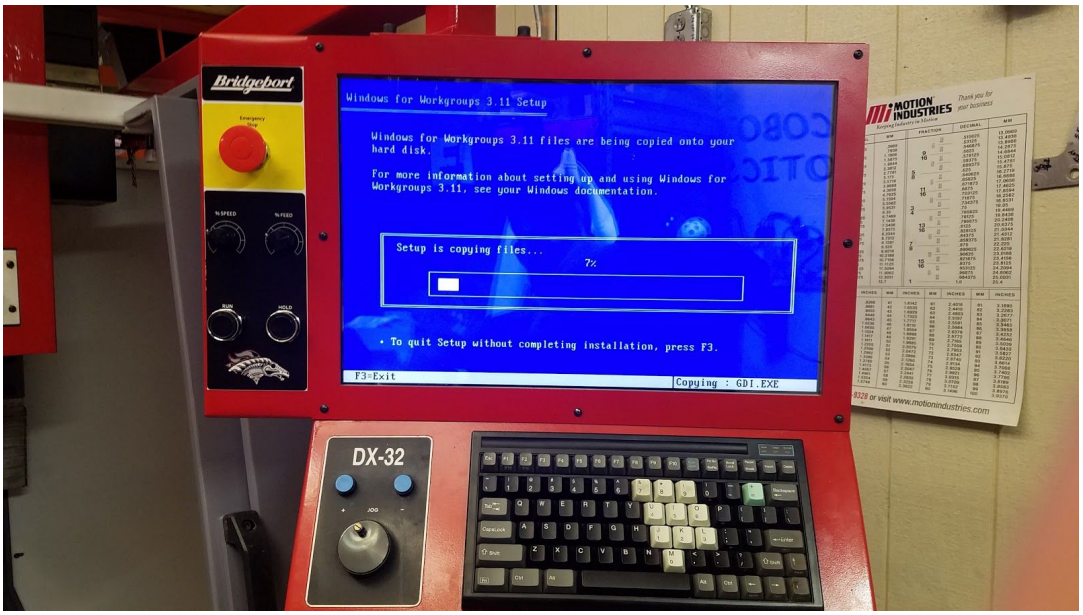
MACHINING CENTER INSPECTION REPORT Reviewed by_____ With_____

	☐ ATC	☐ General	☐ BallBar	Initial for Service
Tool Arm Alignment	☒OK ☐Need Replacement			
Spindle Orientation	☒OK ☐Wear on Dogs ☐Wear on Slots			
Arm Claws	☒OK ☐Wear			
Grid Shift	☒OK ☐Need Adjusting ☐Adjd			
Tool Locking Pins	☒OK ☐Wear			
Air Blow Lubrication in Flow	☒Visual Flow ☐No			
Air Pressure Drop W/MTC	☒ < 5psi ☐NA			
Magazine	☒OK ☐Dog Wear ☐Ret. Ring Wear			
Way Wipers (Not Part of Pkg) _____Authorization to Inspect		☐OK ☐Replace _____Bill Hrs		
Door Interlock	—	☐Functional ☐Not Functional		
Intake Coolant Filter	—	☐Clean ☐Dirty		
Down Load Parameters	—	☐Disk in Electrical Cabinet ☐Disk for Maruka		
Detail Listing Drives Etc		☐Paper Copy in Electrical Cabinet ☐Maruka Copy		
Hydraulic Fitting / Hoses	—	☐OK ☐Leak ☐Other		
Electrical Cabinet Interlock	—	☐Functional ☐Not Functional		
Conduit & Cable	—	☐Good Appearance ☐Worn		
Waylube	✓	_____KFG ☐Leaks _____PSI Y / N Good Distribution		
Door Glass	—	☐Good ☐Damaged		
Backlash			.1 X .1 Y .1 Z	
Squareness			.2 X .0001 Y .0002 Z	
Servo Following Error	—			
Circularity (Non-Roundness)	BallBar NA			
Reversal Spikes	NA		_____X _____Y	
Lateral Play (Slop in Guideways)	✓		_____X _____Y	
Straightness	NA		_____X _____Y	
Scale Mis-Match	NA		_____X _____Y	
Cyclic Pitch			_____X _____Y _____Z	
Machine Level	✓		0 X 0 Y	

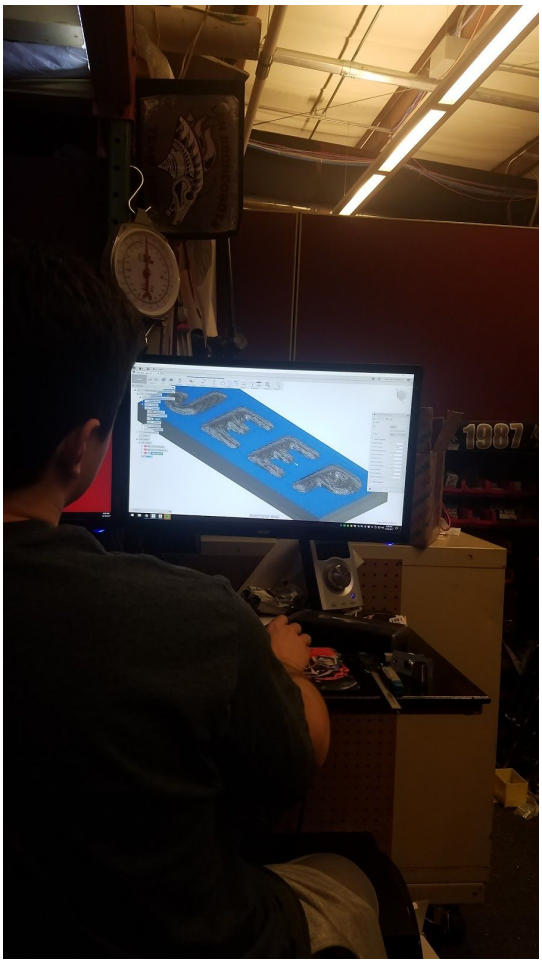
With Jim's work done on the hardware side, Joshua put the rear enclosure panels back on, caulked some of the seams for good measure, and tested the coolant pump. I converted the 527MB hard drive to a 512MB CF card using a CF to IDE converter, upgraded from DOS 6.2 to DOS 6.22, and installed Windows for Workgroups 3.11. The Windows install is to prepare for the putting the CNC on a network to transfer g-code programs quickly without messing with floppies or flash drives. I bought an ISA networking card from Ebay for $5, and with relative ease had a share folder on the network where we can copy our g-code files, no floppies necessary.





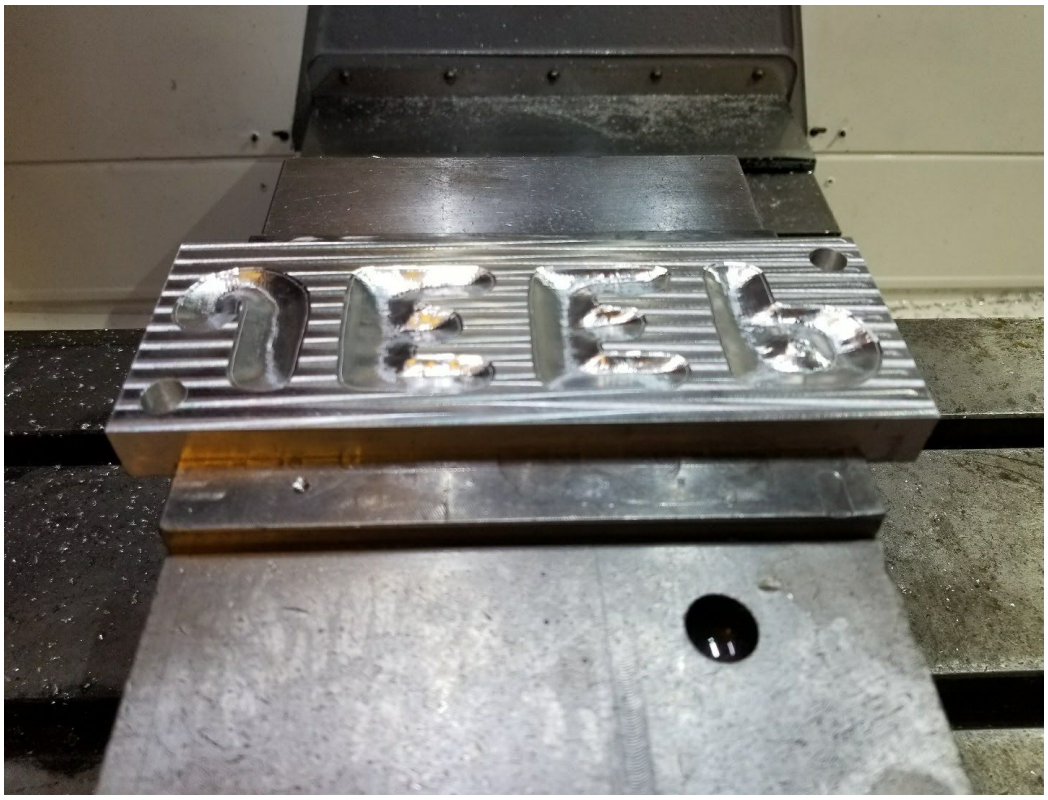
Joshua reached out WM. F. Hurst to to inquire about coolant. They donated 5 gallons of Cimstar Qualstar LF pink coolant for the cost of shipping. We mixed up 10 gallons worth and filled our reservoir. Our shop is relatively small and one concern we had was coolant smell. Based on Joshua's research we needed to keep the liquid moving and the oil off of the top to make the coolant last as long possible and to minimize smell. We went with a nice DIY option from At-Man Unlimited Machining. His solution was a saltwater aquarium pump placed in a bin with slots inside of the reservoir. The pump circulates the coolant underneath and makes the surface of the coolant flow into the bucket, all of the oil on top of the surface is then trapped inside ready to be scooped out regularly.

Finally, we had everything together and ready to go. Now it was time to make a part. Joshua and I tend to go big, thus set out to mill a sheet metal stamp die to be used by some of my Jeep friends who working to restore a 1945 CJ2A. If interested, you can read the restoration thread here: https://goo.gl/ME6Nux
Basically Jeff (aka. Jpet on the 2A pages) gave us a 3D scan that Joshua went off of to model the part and create all of our tool paths using Fusion 360. Once the CAM was done, we set out to run the part.



Almost immediately we hit our first snag. The ISA networking card was yet to be delivered and the g-code file was 5.5MB, a little too large for our 1.44MB floppy disks. We could've split up the tool paths into small files, but we didn't want to go that far. Instead, I tried zipping the file and unzipping it on the DX32. That was being a little difficult and before I figured that out, I realized the "HDD" of the machine is just a Compact Flash card now. So I shut the machine off, pulled the card, and copied the file from one of our workstations.

I then learned how to use the DX32 DNC to execute the large file, and we hesitantly kicked it off. The part ran almost perfectly, from it we think we've found we may have a little runout on part of CAT40 spindle. We are working to diagnose and get that fixed, we'll update once we figure that out.



This machine still has a long life ahead of it, it took A LOT of work and some **very** long weekends. Joshua nor I will say that we are "done" - but I think I can safely say that our primary restoration is complete!

We have been fortunate enough to receive a couple more generous donations of equipment for our machine. The Kurt vise that we have now was donated for $10 by Eric Weiler at New Mill Capital. After Joshua reached out to our regional Haimer representative, Matt, who donated a 3d sensor to make setting work offsets easier for our students. We are now working on finding tooling, and a few more Kurt vises.
Finally, a big shout out to the Torq Cut/DX32/CNC community, through your forum posts and YouTube videos we've found answers to many of the "new to us" questions we've had.


Bridgeport
DISCOVERY
TORQ-CUT
22
X -11.1853
Y -6.3914
Z -5.8114
DX-32