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# The Think Tank: My Introduction to one of BSU's Makerspaces

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# The Think Tank: My Introduction to one of BSU's Makerspaces

*Toby Lorenzen*

As I met Dr. Michael Black in the computer science department, I asked about the status of the Makerspaces that he, Rob Monteith, Rob Lorenson, and Robert Hellstrom oversee. "Great," he answered, "Would you like a tour of the Think Tank Makerspace?" I answered, "Sure. What exactly is a Makerspace?" As he walked me down to the ground floor of the Math and Science building, he explained, "A Makerspace is where makers make things." I thought to myself "Well, I've been making wooden bowls on a lathe for a long time, so I guess I'm a maker," but I did wonder how this Makerspace would differ from my woodworking shop. As we entered DMF 151, christened the "Think Tank," I had my answer: each piece of machinery in this room was somehow controlled by a computer.

Dr. Black introduced me to Rob Monteith who supervises this space, and to my future student mentors, Kevin Monteith, Amanda Morrison, and Keith Phelan, and left me in their capable hands as he ran off to teach a class. I recognized some 3D printers because I had made some two-inch tall 3D action heroes on a $10,000 3D printer ten years ago. (The Think Tank's tiniest 3D printer now costs $200!) I was especially interested when Kevin pointed out a CNC router system to me because I had heard of them and the mysterious CAD/CAM acronym but had never seen one. I gathered it could cut out anything (from wood or aluminum) that I could draw in 3D on a computer.

***Image 1:*** *(Author's Photo)*

***Image 2:*** *(Author's Photo)*

When I saw Amanda rotating a 3D brain model on her computer screen, I suspected that "drawing" might not be a simple or straightforward process.

Weeks ago my dentist had taken hundreds of pictures of my sorry tooth and had stitched the pictures together into a 3D model that would be used to produce my crown. Amanda said that they had similar technology in the Think Tank that I could use to load 3D images of wooden pieces into the computer and arrange them into 3D sculptures. When I created a sculpture I liked, I could build it up layer by layer on a 3D printer or I could carve it in wood using the CNC router. Then I could photograph the piece in the evenly lit light box that is in the Think Tank for that very purpose.

I was intrigued by all these possibilities and asked what I had to do to use the CNC router. I was told that the first step was to sign on to http://bridgewaterhub.org/ and read documentation covering the operation of all the machines in the room and pass a multiple-choice safety quiz on that information. Next I had to start learning how to draft 3D drawings on the computer using a computer program called Inventor. Inventor is used to turn ideas into working diagrams and then to make a prototype from them on a 3D printer or CNC router.

I collaborate with Bob Beardsley in making laminated bowls. The technique we use, called making a Bowl from a Board (BFB), starts with gluing up differently hued woods into a 12" square board 1 ½" thick. We tilt our scroll saw table to the correct angle and cut a 12" diameter circle out of the 12" square board. This circle is then further sawed into five evenly spaced concentric rings leaving a central 7" diameter disk. The rings are stacked and glued forming the bowl's wall and the central disk becomes the bowl's foot. This glue up is then turned into a smoothly

*Image 3: (Author's Photo)*

shaped bowl on a lathe. Image 1 shows a bowl we made pre-Makerspace with the waste below it. Image 2 shows the upside down bowl surrounded by the waste. The irregular white pattern of triangles arose from the white sapwood found along the outside edges of the walnut boards. Hopefully you can visualize what the original 12" square looked like and see what each piece of walnut and yellow heart contributed to the finished bowl.

Cutting out the rings at the correct angle should produce a funnel-shaped bowl with straight walls. I misunderstood the calculation of this correct angle and produced a bowl that looked more like a circular Mayan stepped temple than a funnel. I bemoaned this sorry state of affairs to Joe Matta (a Think Tank lab tech) and he modeled the bowl in Inventor in perfect detail and pointed out my faulty assumption on his diagram. Thanks to Joe, our bowl walls have now straightened out.

Also, pre-Makerspace, Bob and I had made a walnut BFB with six columns of windows cut out of its sides. To do this, we made a jig and used a handheld router to excavate six long triangles radiating from board's center down ½" into the 1 ½" thick square of wood. Our problem was that we would have to make a new jig for each different size bowl we wished to make. I wondered if Inventor could be cajoled into making a general-purpose model that would allow the CNC router to cut triangles for any size bowl if we input the rim and foot diameters of the bowl.

I used the maker website to request lab time with Kevin (he approved my request) and brought him the windowed bowl made using our jig and asked if the CNC router could be programmed to cut triangles into any size square stock. His short answer was "Yes," and he followed up with "But you need to understand that this is not a shop—it's a Makerspace." After a bit of listening, I gathered a shop is a place where I go to get a machinist to make something for me and this was not such a place. This was a place where I must learn how to make the piece with major, continuing guidance from these student mentors. If I didn't like that deal, I was welcome to go to a shop.

To learn Inventor I studied the four Inventor tutorials Keith had written: https://www.bridgewaterhub.org/resources/tutorials.php and attended the three hands-on modeling workshops when offered during the semester. Kevin volunteered to become my main mentor since he has the most experience on the CNC router.

After Kevin understood how I wanted to arrange the six triangular cutouts in my 12" walnut square, he led me

*Image 4: (Author's Photo)*

*Image 5: (Author's Photo)*

*Image 6: (Author's Photo)*

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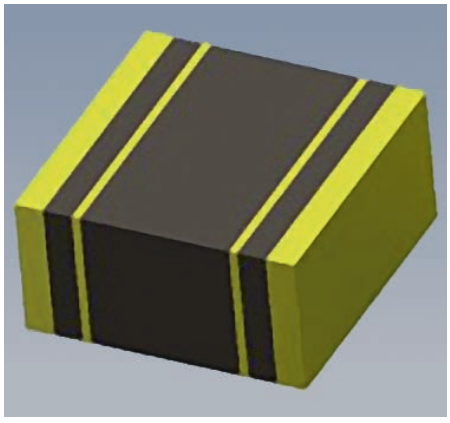

*Image 7: (Author's Photo)*

through the process of making a 2D sketch, extruding the sketch into a 3D solid, marking out one triangle and using a circular pattern to produce six evenly spaced triangles from that one original triangle.

When I described a project I would like to work on, Kevin would tell me to find videos on specific topics that I must master. For example, when I wanted to draw a 3D bowl, I was assigned to watch videos on Loft and Revolve. With that info under my belt, at our next meeting he would rapidly click and produce a 3D bowl. Then I would slowly try to reproduce his series of clicks. When I got stuck, he would click me through my impasse. After a couple of weeks of studying videos, I could use Inventor's CAD (Computer Aided Design) to sketch simple 3D models. "So, can we use the CNC router now?" I asked. "Weeell not quite. You have to learn CAM (Computer Aided Manufacturing) to tell the router what kind of cuts you want to make and in what order to make them."

To cut out the six triangles from the walnut square required filling in four windows of information for each of the Facing Cut (flattens the board), Pocket Cut (roughly cuts out the triangles), Contour Cut (to smooth the sides of the cutouts), and Horizontal or Parallel Cut (to smooth the bottom of the cutouts). Take a look at the result of our first Makerspace project (Image 3). When we later used the saw to cut the 12" wood square into rings, we cut through the flat-bottomed triangular cutouts at a 27 degree angle. We rotated every other ring 180 degrees before glue up to produce the finished bowl (Image 4).

For our next windowed bowl, I asked to make red ¼" thick triangular inserts of red heartwood to glue to the bottom of the excavated triangles. That required learning about CAD

assemblies and constraints and using the CAM 2D Contour Cut to cut along the edges of the red triangles to free them from their parent board.

I realized just before sawing the rings out that the red window attachments would appear on the upper edge of the window instead of the bottom edge where they would be more effectively seen. To counter this problem, we flipped our 12" square over and cut out the rings. This resulted in a crenulated bowl rim that we sanded flat. More insidiously, the partial windows of the foot moved from the bottom to the top of the foot. When I turned away those partial windows, the foot was now too small to glue to the ring above it. We glued in a new piece of wood instead and added a red foot. See Image 5 for the glue up. In right to left order, we have the metal faceplate (threaded to the lathe like a nut on a bolt) attached to the waste block with six screws, red foot, new wood replacing old foot,

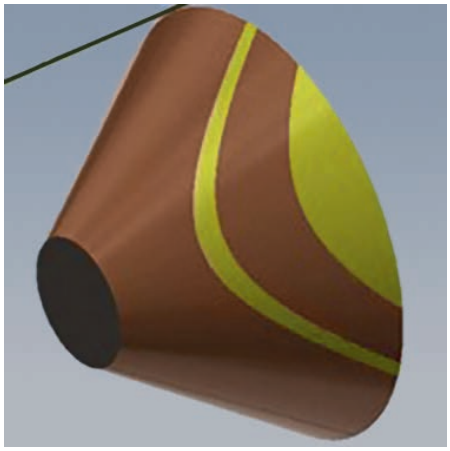

***Image 8:*** *(Author's Photo)*

original rings. See the finished bowl (Image 6). What is particularly interesting to me is how straight pieces of yellow heart produce curved patterns in the bowl. It is not obvious to me that this should be the case. In fact, if we made a more complicated 12" square with curved wood instead of straight wood, I can't visualize what the bowl would look like. I asked Kevin if we could work on an Inventor CAD sequence of steps to start with an arbitrarily patterned 12" square and mimic the steps Bob and I do in the workshop to produce a bowl. If the computer model didn't please, we could save a week of work and $50 of wood by not making a bowl we didn't like. My homework assignment was to assemble brown and yellow colored rectangular boxes into a computer model of my actual 12" board.


***Image 9: The author with Kevin Monteith*** *(Photo Credit: Amanda Morrison)*

Unfortunately, mimicking the steps Bob and I do in the workshop in a CAD model was quite complicated and the project was tabled. A week later I had a new idea: I took the 12" multihued square that was 1 ½" thick and modeled it to be as thick as the finished bowl was tall (Image 7). Now (as Michelangelo was rumored to have said) "The bowl was trapped in the block and if the non-bowl parts were removed, the bowl would emerge." I watched videos all weekend searching for a similar problem and speculated that maybe the Sculpt or Split CAD commands could be useful. Kevin later used the Split command to remove the non-bowl parts from my block and produced a model (See Image 8). Compare that model with the actual bowl previously shown in Image 1. Keith suggested an alternative method; he used the Revolve command to shave away the unwanted wood from the model as a machine called a shaper might do in a traditional woodworking shop. What a major breakthrough for our team!

Amanda took Image 9 of the CNC Router flanked by the author and the mentor. I wish to thank Kevin, Amanda, Keith, and Joe for all the help and encouragement they gave me that made the new bowls possible. We encourage you to pass the safety quiz, take a workshop, and become a BSU maker!

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