

**SHERLINE
PRODUCTS**
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NOTE: We recommend using the aluminum block in your first attempt at making the Jack-in-a-box. The aluminum is more forgiving and less expensive on which to practice.

Making a "Jack-in-a-Box" Puzzle on a Sherline Milling Machine J1000 Kit

Making a Jack-in-a-Box Puzzle

This is a fun project you can make on your Sherline Mill using a Sherline 4" Rotary Table, a 4-Jaw Self-Centering Chuck, and a 1/8" diameter end mill (this size end mill provides enough flute length to be able to mill the required .350" deep trepanned groove. If you choose to use a smaller block you can get away with a smaller diameter end mill having less flute length.).

Detailed Equipment List You Will Need for this Project

- Sherline Mill
- Sherline 4" Rotary Table*
- 4-Jaw Self-Centering Chuck, P/N 1075 (2.5") or P/N 1076 (3.1")
- Chuck Adapter, P/N 37090 (included for fastening the chuck to the rotary table)
- 3/8" diameter end mill holder, P/N 3079
- 1/8" End Mill, 3/8" Shank, P/N 7402 (2-Flute)
- * **NOTE:** If you already own a CNC mill you do not need a rotary table. You can, instead, write a G-code sequence to accomplish the task.

To keep things simple we are going to use a 3/4" square brass or aluminum cube which can be made on the mill using either a vise or the 4-jaw chuck. Any size block can be used for this project and the dimensions adjusted to suit your own requirements. See Figure 8 for reference dimensions.

To start we will divide the block into 4 features, The CAGE, STEM, HUB, and TREPAN GROOVE. The outer case of the cube is the CAGE (Figure 1), the six spokes of the inner part make up the STEM (Figure 2), the central joint of the stem is the HUB, and the circular groove separating all the parts is the TREPAN GROOVE.



FIGURE 1—Cage and Stem

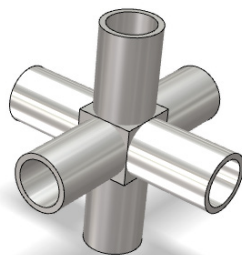


FIGURE 2—Stem detail with optional holes

We will make the STEM .200" diameter. The CAGE will be .75" square. If we work from the centerline out with the radius of the stem being .100", the frame at .075", that leaves the width of the TREPAN GROOVE to be .200". Another dimension we must contend with is the depth of the TREPAN GROOVE. With the distance from the surface to centerline being .375" we will deduct .125" (the radius of the stem + .025") making the depth of the TREPAN GROOVE at .250" leaving a .250" cube (the HUB) at the center in our project.

NOTE: If you choose to perform the optional machining to lighten your piece, start by drilling a hole through all sides using a 5/32" diameter drill as shown in Figure 2. When drilling the holes we suggest you center drill first. Drill the 5/32" hole only slightly past center of the intersecting hole so the drill will not wander. The drilling can be done on either the lathe or mill. You should machine the chamfer on the mill as shown in Figure 3. After machining the TREPAN GROOVE, chamfer all edges as shown in Figure 4.

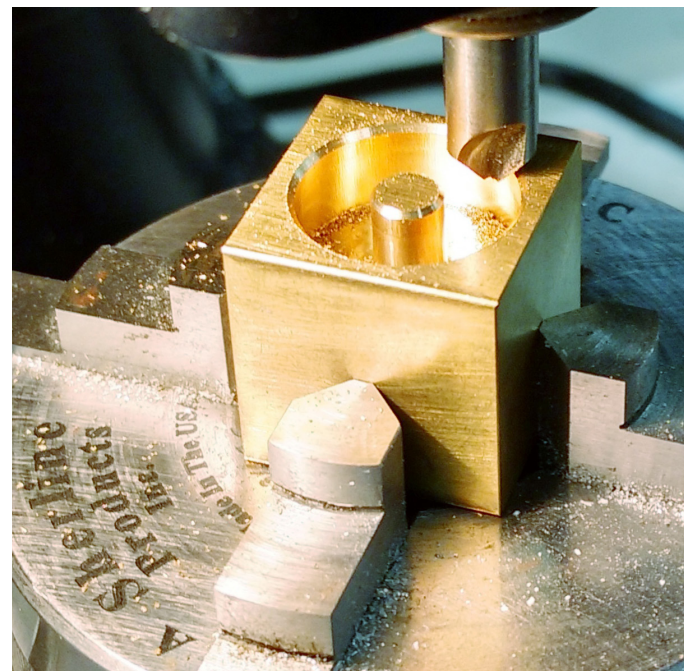


FIGURE 3—Chamfer the TREPAN GROOVE

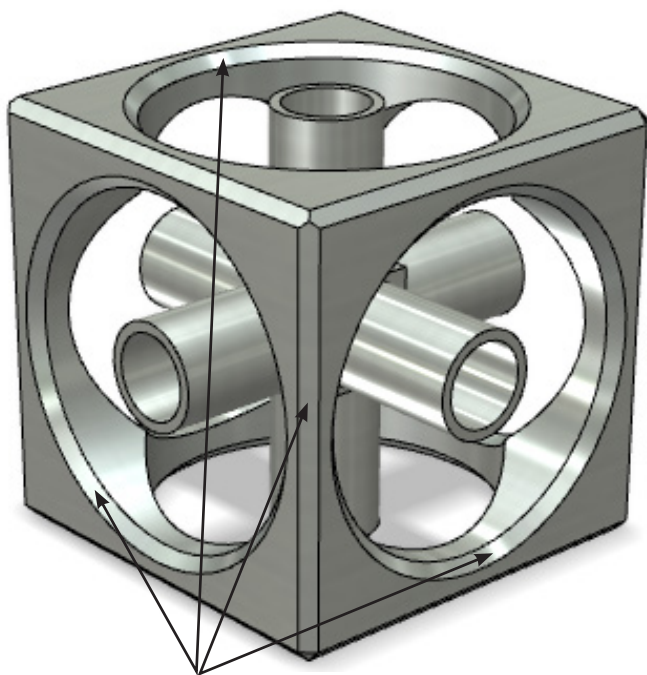


FIGURE 4—Example of chamfered edges

Mount your rotary table on the mill and tram the center hole of the rotary table to the center of the spindle. Set your X & Y dials to "0". Any move you make from center you will make using the X axis. The Y axis will remain at 0.

To machine the TREPAN GROOVE you will use a 1/8" diameter end mill. Using a 1/8" diameter end mill to machine the .200" wide TREPAN GROOVE leaves you with approximately .037" of material to remove per side. We suggest you take a depth cut of no more than .020" per pass leaving .005/.010" on the bottom for a finish pass. We suggest you rotate your rotary table so you are climb cutting to remove approximately .010" of material at a pass with a final pass of .003/.005" (See Figure 5).

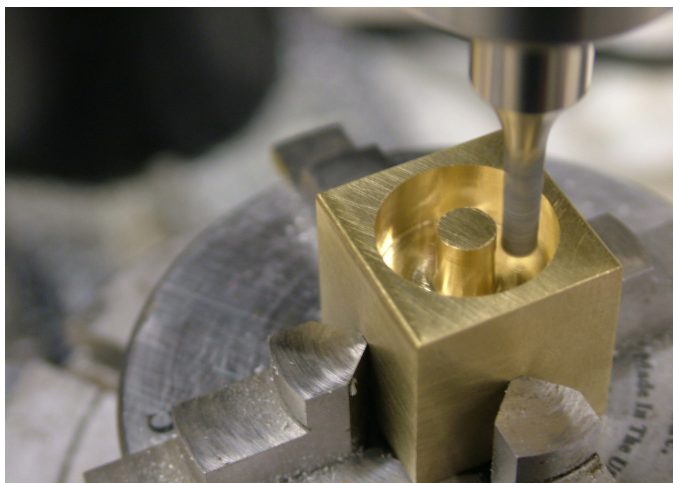


FIGURE 5—Milling the TREPAN GROOVE

Working from the centerline of the TREPAN GROOVE we have a centerline of .200" radius (.100" radius of the stem + .100" center of the PAN GROOVE = .200" radius.) You will move your mill table .200" either + or – and this becomes the centerline of our TREPAN GROOVE. You may want to establish this as your new zero (0) or record this position for future calculations. You are going to machine this TREPAN GROOVE on 4 adjacent faces of the cube (leaving the two opposing faces to support the 4 finished STEMs.) After making your TREPAN GROOVE to depth, move .037" toward the stem and .037" toward the frame to widen the TREPAN GROOVE to .200" by .250" deep.

Once you have machined the four adjacent TREPAN GROOVES, leaving the four faces of the HUB, you are going to use our MACHINABLE WAX to support the inner structure while you machine two more TREPAN GROOVES. This wax can be purchased through SHERLINE and comes in a package sufficient to do five or six cubes. The wax melts at approximately 175 degrees Fahrenheit and can be melted by various means, such as on a hot plate. You can make a melting pot from an old tuna or cat food can, and bending a pour spout on one side as shown in Figure 6.



FIGURE 6—Melting pot

Figure 7, on the following page, shows the method used to form an envelope of aluminum foil around five of the six sides to contain the molten wax. After cooling to room temperature, peel off the foil and scrape and/or sand away any protruding wax to make all surfaces flush.

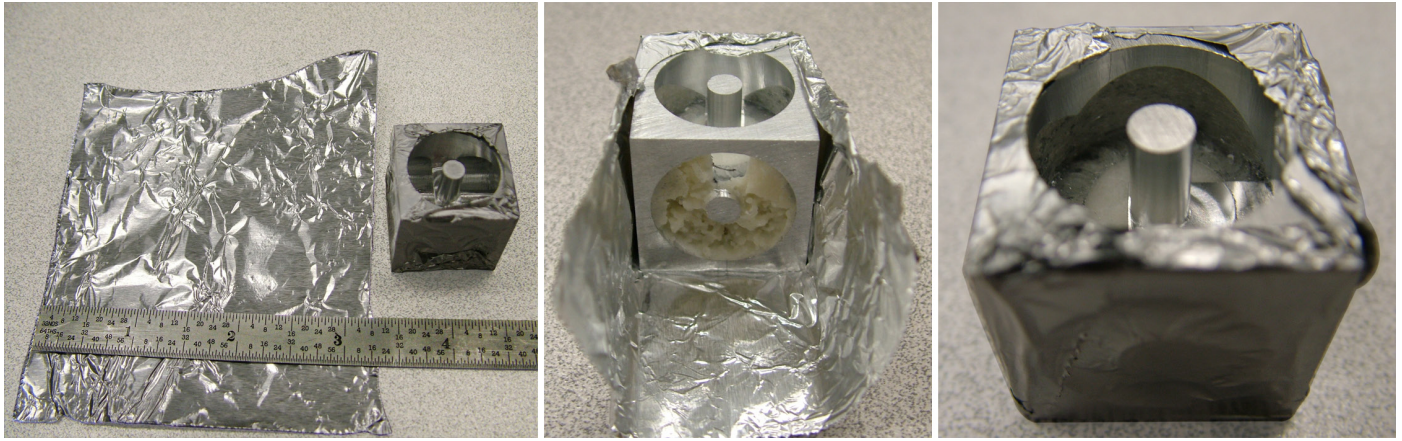


FIGURE 7—Wrapping the cube in foil

Next, you will machine the fifth face as we did the other four and again fill that void with wax so as to have all five machined features filled with the wax. Now you can finish machining the sixth face taking very light cuts as you are now holding onto the center piece with just the wax.

After completing this last operation the only thing left is to melt the wax out of the part by immersing it in hot water. You now have your finished JACK-IN-A-BOX PUZZLE to burr and finish as you desire and show to one and all who will ask, “HOW DID YOU DO THAT?”

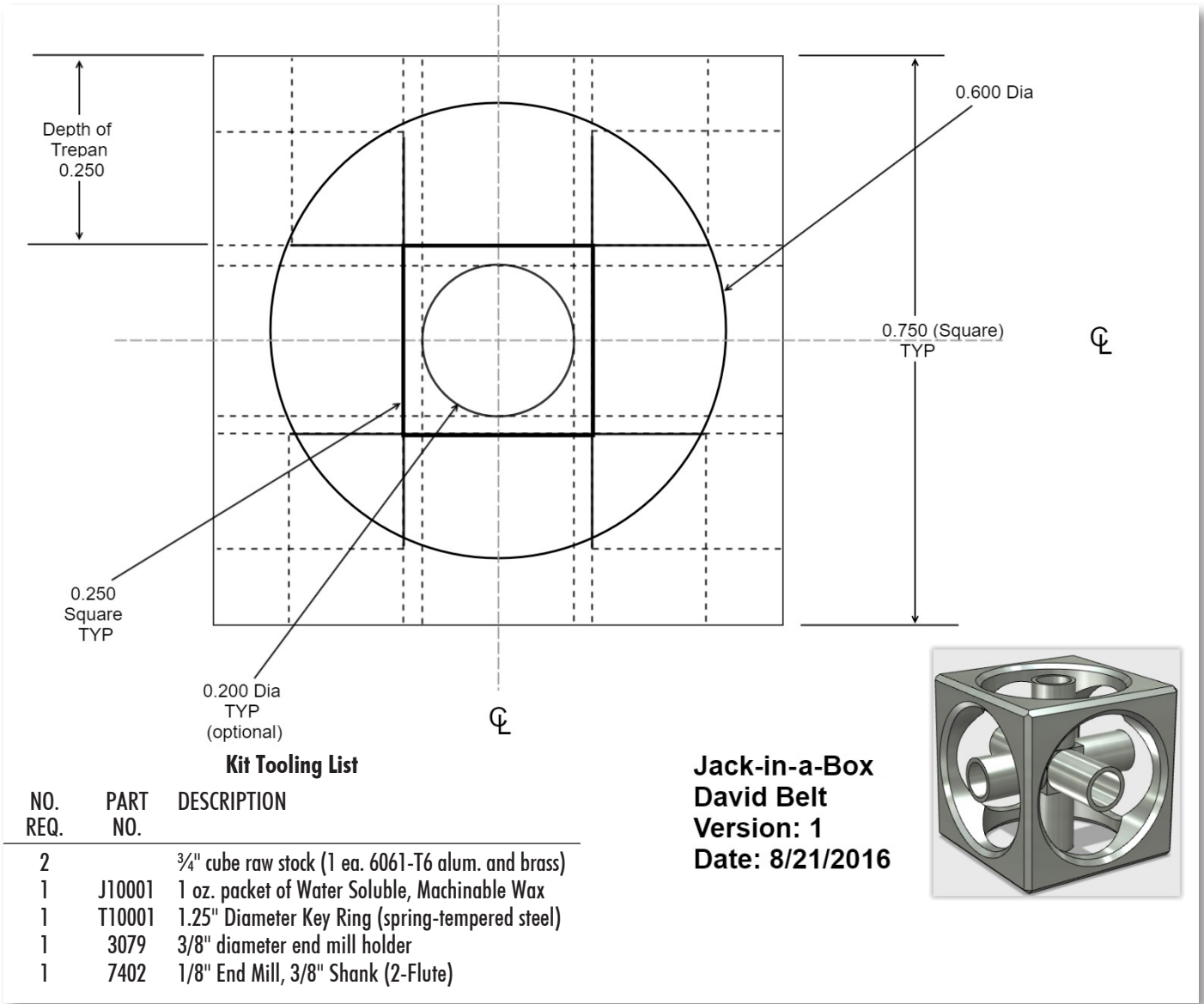


FIGURE 8—Dimensional drawing