# Burr Puzzle Creator Operations Manual



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### Section 1: Introduction and Background

The Burr puzzle is a wooden block and slot type puzzle which assembles to into the form shown in figure 1. Multiple variations of the Burr puzzle exist, and the puzzle making machine can be adapted to make any of the puzzles in the notchable category. A single Burr puzzle requires six blocks, however the machine will cycle through the six parts as long as stock loaded.



Figure 1 – Assembled Wooden Burr Puzzle

The remainder of this manual is split into three sections, section 2 contains instructions for activating and loading the machine, deactivating, jam clearing and changing the puzzle type. . Section 3 covers the machine specifications and explains the operation of the machine. Section 4 contains the programmable logic controller (PLC) ladder diagrams which control the machine.

## **Section 2 – Instructions for Operation**

The following instructions should be followed when ever the machine is to be operated. The operator should keep in mind that the machine may move automatically and that the router may start as soon as power is applied. Always wear eye and hearing protection and never leave the machine unattended. Precautions, such as minimizing access to the router blade, have been taken, but dangerous situations are inherent. Caution should be taken.

- 1) Activating the machine
  - a) Remove all chips or puzzle pieces from the machine and conveyer belts.
  - b) Connect the main power supply to a 120VAC source.
  - c) Verify that the brake switch on the DS controller is set to "Release" and that the port switch is set to "off".
  - d) Rotate the red button on the power supply clockwise to active the machine. The intelligent actuator will initialize and then go to the first position. The display on the DS controller will read "P01".
  - e) Switch the PLC switch from "Stop" to "Run".
  - f) The machine is now ready to make parts, load blocks one at a time, in an approximately lengthwise orientation onto the tilted conveyer belt.
- 2) Deactivation Procedure
  - a) When all the desired blocks have been processed depress the red button on the power supply to turn off the machine
- 3) Clearing Jams
  - a) The moment a jam is detected depress the red button on the power supply. With the power off the pneumatic actuators can be manipulated by hand to release the jammed part
  - b) Reset the PLC switch from "Run" to "Stop" and follow the activation procedures outlined above to restart the machine.
- 4) Changing Puzzle types

The machine comes pre programmed to cut David Winkler's favorites level 5 burr puzzle. To chance to another type of puzzle:

- a) Open the DirectSoft32 application.
- b) Enter the memory editor (CTRL+Y).
- c) The v1200, and on, memory locations represent six blocks. Binary numbers represent the cut pattern on the block where "1" represents a cut. So the pattern 111111 would cut all possible slots. The pattern 000001 would cut only the first slot, and so on.

#### Section 3: Specifications & Operations

The block cutting machine was designed to meet the following specifications:

- a) Raw material: Hardwood blocks of dimensions 0.75 x 0.75 x 2.25 inch,  $\pm 0.003$
- b) Machine must be capable of cutting up to 4 notches on block face 1 and up to 2 notches on face 2. The blocks are cut so that no more than 2 lbs force are required to assemble the puzzles. Blocks should be interchangeable between various puzzle types.
- c) The blocks must enter and exit the machine on a conveyer
- d) The machine must interface with a dust collection system
- e) The machine must minimize jams and assure that jam clearing is a safe and easy operation.
- f) The machine should implement noise reduction measures, with the target goal of 72 dBA at 1 meter.

With the design criteria in mind, the machine was built to minimize block movement. All blocks follow the same path through the machine, regardless of cut pattern. Referring to figure 2 on page 3, the blocks enter on the inclined entry conveyer. An optical sensor will trigger the gate if a block is in place and if the intelligent actuator is in position. A sensor on the backstop will detect the fallen block and command the intelligent actuator to move towards the block 3/8". The sacrificial clamp will then activate, followed by the main clamp. The intelligent actuator will then move the clamped block into all four cutting positions, and the router will make cuts based on the preprogrammed block setting. During the cutting phase the maximum noise level is near 96 dBA, the idle volume reduces to 86 dBA. The intelligent actuator then slides such that the block is fits into the cradle on the rotating assembly (see fig 3, page 3), and release the block. The rotating assembly will rotate, and the block will be re-clamped and carried to the final two cutting positions. Once the cuts are complete, the intelligent actuator will position the block over the exit slide and release the slide. A pneumatic cylinder will retract, carrying the block to the exit conveyer. The intelligent actuator will return to the initial position, and the process will repeat.



Figure 2 – Machine Layout



Figure 3 – Rotating Mechanism