

To:Cutting Module Design TeamsFrom:Ralph Stirling, Manufacturing EngineerSubject:Analysis of 2001 Model Slot Cutting MachineDate:2003-04-13

2 hours to take measurements and write memo.

Summary Summary

I analyzed the current Slot Cutting machine and several sample parts produced by it, and have found several critical improvements that must be made in the next generation machine. Production of acceptable puzzle pieces is impossible with the current machine.

The deficiencies I observed were these:

- Feeding approximately ten attempts were made to feed blocks. Every attempt required some degree of manual intervention before the block was positioned for cutting. The microswitches used for detecting part position can hang up on previously cut slots, a problem since the new generation machine will need to perform cutting on the second face of parts.
- Part quality measurements of finished parts showed that the machine is misaligned in cutting angle and depth, and that repeatability of cut depth and position is lacking. Some tear-out on cutter exit was also observed, possibly due to excessive feed rate.
- Alignment it is difficult to correct the alignment problems, because of the inaccessibility of the block cutting position when the machine is assembled.
- Bearing assembly some part defects may be due to vibration and deflection of the router guide rails during operation.
- Cycle time cycle time was approximately 12 seconds per part. Desired cycle time is under 10 seconds per part.
- Dust and noise dust collection is vital to production use of this machine, as the plant personnel have not been taking an active role in controlling dust. Noise abatement would make the plant environment more pleasant.

Measured Data

Machine measurements:

- Router plate vertical displacement was 0.004" over the full travel of the carriage. This displacement was not monotonic (i.e., it went up and down several times over the full travel distance)
- Vibration amplitude with the router running (at 22000 RPM) was observed with a dial indicator to be about 0.003", with the router carriage stationary (not cutting).







Part measurements:

- Angle error E was approximately 0.01", giving an angular error of about 0.76° (comparing with dial caliper by eye).
- First-pass to second-pass cutting offset D was approximately 0.005" (again comparing with dial caliper by eye)
- Both router full-depth cutting passes sloped by about .005", and had an offset between slots that varied from 0.000 to 0.0045".

Block	А	А	Slope	В	В	Slope	Offset	C avg
#	min	max	(Amax-	min	max	(Bmax-	(Bavg-	
			Amin)			Bmin)	Aavg)	
1	.361	.367	.006	.365	.372	.007	.0045	1.372
2	.368	.375	.007	.365	.370	.005	.004	1.431
3	.367	.373	.006	.368	.374	.006	.001	1.524
4	.361	.365	.004	.361	.365	.004	.000	1.432