SIEMENS

Tic, Tac, Toe

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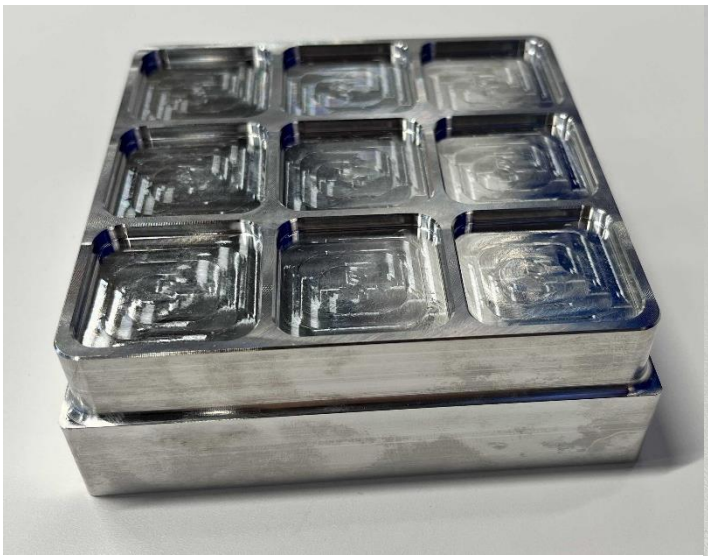
CNC4you "Tic, Tac, Toe" workpiece

The CNC4you "Tic, Tac, Toe" workpiece is a milled part for 3-axis milling machines. It comprises a game board and 10 game pieces.



Game board

Game pieces

All the information required to machine the part is subsequently listed – such as tool data, machining plans and NC programs.

www.siemens.com/cnc4you

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1 Safety note

Handling machines involves dealing with a wide range of risks. When fabricating the CNC4you "Tic, Tac, Toe" game, it is crucial that the usual operational safety regulations are carefully complied with.

2 Preliminary comments

The following description addresses technicians familiar with CNC machines and who have experience and are knowledgeable about SINUMERIK CNC control systems. All the technology data listed here correspond to the machines, tools, materials, job plans and drawings used to fabricate this prototype. Due to the wide diversity of resources available in other workshops, this data only serves as example for replication. Nevertheless, in most cases it should be possible to simply replicate this game.

The program for the milled part was generated and tested on a 3-axis CNC milling machine. The machine was equipped with a SINUMERIK 828D with ShopMill. SINUMERIK Operate V4.95 was installed on the machine.

Generally, NC programs can be simply adapted to other SINUMERIK versions, for example, to other SINUMERIK Operate software releases. A simulation and necessary modifications should always be carried out – for example, the zero points.

All CAD drawings, programs and machining descriptions for the workpieces can be downloaded at no charge from **www.siemens.com/cnc4you**. You can find the following files and formats for this nifty game here:

- NC programs for machining (3-axis milling machine)
- Workpiece drawings and 3D data (as PDF or STL file)

3 Workpiece, blanks/bill of materials

For the game board: An aluminum cuboid with dimensions 105 x 105 x 41 mm

For the game pieces: An aluminum cuboid with dimensions 120 x 175 x 7 mm

4 Machines and NC programs

CNC milling machine:

- Type: Mazak VTC-530-C 3-axis milling machine
- CNC: SINUMERIK 828D with ShopMill V 4.95

NC programs:

- SP01_WW1.MPF – Milling the game board, lower side
- SP01_WW2.MPF – Milling the game board, upper side
- SP02_WW1.MPF – Machining the lower side of the game pieces
- SP02_WW2.MPF – Machining the upper side of the game pieces

5 Tools used

Tool/short name	Description
FRAESER_D4	End mill, 4 mm diameter
FRAESER_D10	End mill, 10 mm diameter
ALU_D16	End mill, 16 mm diameter
ALU_D63	End mill, 63 mm diameter
STICHEL_D4	4 mm stylus or milling tool with 90 degree cutting edge angle *)
FASER_10_VHM_4SN	10 mm chamfering tool, 4 cutting edges

The tools are defined in file TIC_TAC_TOE_TMZ.INI. After loading the tool list, the availability of all tools required can be checked using program TOOL_CHK.TTD.

6 Fabricating the "Tic, Tac, Toe" workpiece

Fabricating the game involves milling the game board and the game pieces.

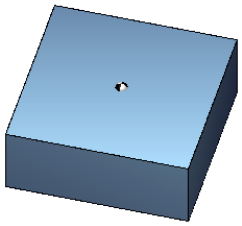
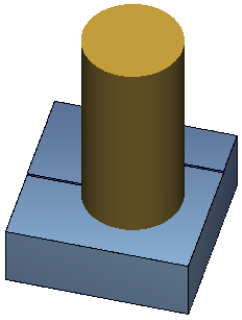
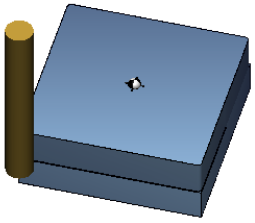
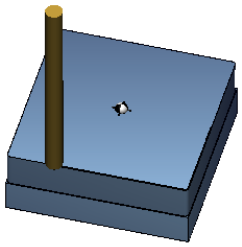
6.1 Game board

Machining sequence

1. Approach the machine reference point.
2. Read-in the machining plan for machining the rear side: SP01_WW1.MPF
3. If you have not already done so: Read-in tool list TIC_TAC_TOE_TMZ.INI
4. If you have not already done so: Measure the tools, enter in the tool list.
5. If you have not already done so: Insert the tools in the magazine.
6. Attach the clamping fixtures.
7. Using the clamping fixtures, clamp the blank to machine the rear side.
8. Set the workpiece zero, by scratching for example
9. Check the work offsets programmed in the part program and if required, appropriately adapt to the actual machine configuration.
10. Perform the simulation, check for collisions or contour violations. If required, make the appropriate corrections until the simulation runs without any errors.
11. Start machining, execute machining plan SP01_WW1.MPF
12. Reclamp the workpiece for machining the upper side
13. Read-in machining plan SP01_WW2.MPF
14. Set the workpiece zero, for example by scratching
15. Check the work offsets programmed in the part program and if required, appropriately adapt to the actual machine configuration.
16. Perform the simulation, check for collisions or contour violations. If required, make the appropriate corrections until the simulation runs without any errors.
17. Start machining, execute machining plan SP01_WW2.MPF
18. Remove the workpiece

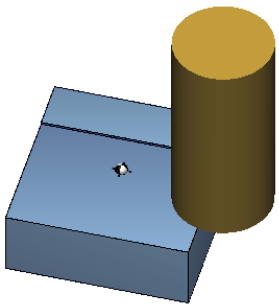
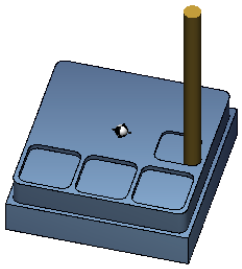
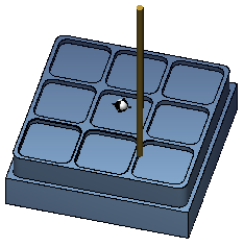
6.1.1 Sequence of NC program SP01_WW1.MPF

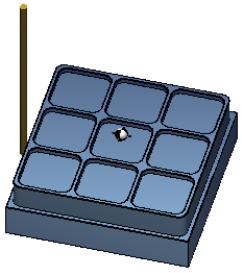
NC program SP01_WW1.MPF machines the lower side and the outer contour of the game board.

Machining step	Photograph
Blank for the game board	
Machine the lower side	
Mill the game board contour	
Chamfer the lower edge of the game board	

6.1.2 Sequence of NC program SP01_WW2.MPF

NC program SP01_WW2.MPF machines the upper side of the game board. To do this, the workpiece is clamped with the already machined lower side facing downward.

Machining step	Photograph
The upper side of the game board machining begins by removing stock to the target thickness and finishing the surface.	
Mill the pockets for the game pieces	
Chamfer the game piece pockets	

Chamfer the upper edge of the game board and at the step in the outer contour.	
Completed game board	

6.2 Machining the game pieces

Note regarding potential risk and machining

When machining the upper side, all game pieces are milled out of one and the same flat base body. After milling the circle or cross contour, the newly finished game piece is no longer clamped and is loose. Without being additionally secured, the game piece can be torn off uncontrollably and flung away by the cutting forces when milling the last tenth of a millimeter of the contour (danger from flying parts, poor contour quality). It is important that this is completely ruled out:

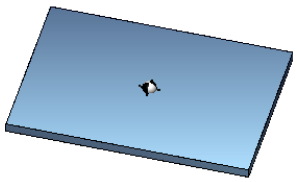
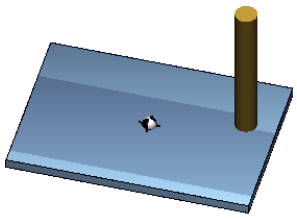
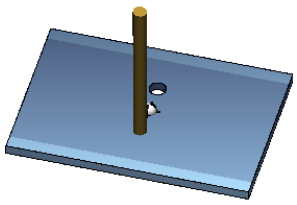
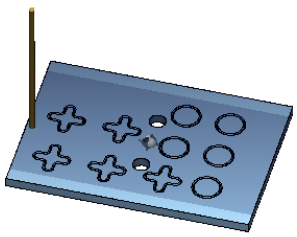
- The best solution is to use a vacuum table that holds the pieces in position using suction until machining has been completed
- The other solution is to glue the workpiece flat onto a metal or plastic support before machining the top surface (e.g. using double-sided adhesive tape) and/or
- Reduce the feedrate in a controlled fashion using override at the end of each game piece contour

Machining sequence

1. Approach the machine reference point.
2. Read-in the machining plan: SP02_WW1.MPF
3. If you have not already done so: Read-in tool list TIC_TAC_TOE_TMZ.INI
4. If you have not already done so: Measure the tools and enter the data in the tool list.
5. If you have not already done so: Insert the tools in the magazine.
6. Attach the clamping fixtures.
7. Using the clamping fixtures, clamp the blank to machine the rear side.
8. Set the workpiece zero, by scratching for example
9. Check the work offsets programmed in the part program and if necessary appropriately adapt to the actual machine configuration.
10. Perform the simulation, check for collisions or contour violations. If required, make the appropriate corrections until the simulation runs without any errors.
11. Start machining and execute machining plan SP02_WW1.MPF
12. Reclamp the workpiece for machining the upper side (see risk note above).
13. Read-in machining plan SP02_WW2.MPF
14. Set the workpiece zero, for example by scratching or by using a suitable SINUMERIK measuring cycle (2-hole measurement)
15. Check the work offsets programmed in the part program and if necessary appropriately adapt to the actual machine configuration.
16. Perform the simulation, check for collisions or contour violations. If required, make the appropriate corrections until the simulation runs without any errors.
17. Start machining, execute machining plan SP02_WW2.MPF (see the risk note above).
18. Remove the workpiece

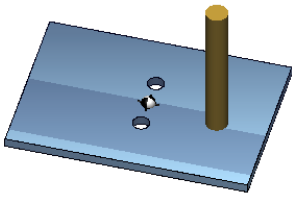
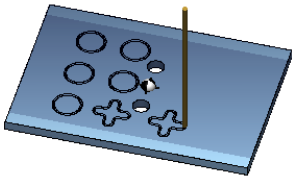
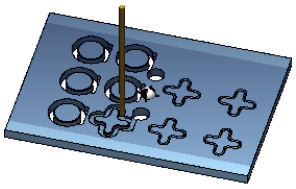
6.2.1 Sequence of NC program SP02_WW1.MPF

NC program SP02_WW1.MPF machines the lower sides of the game pieces.

Machining step	Photograph
Blank for the game pieces before machining the lower side.	
Finish the surface in the area from which the game pieces are milled out of the blank.	
Mill two "holes" as orientation for possibly determining the zero point using the SINUMERIK measuring cycle "2 holes" for subsequently machining the upper side	
Mill the chamfer at the lower side of each of the future game pieces.	

6.2.2 Sequence of NC program SP02_WW2.MPF

NC program SP02_WW2.MPF machines the upper sides and contours of the game pieces and in so doing releases them from the blank. For this reason, if possible, use a vacuum table or glue the premachined lower side of the blank onto a holding plate (sheet metal, aluminum, plastic ...), e.g. using spray adhesive or double-sided adhesive tape.

Machining step	Photograph
Notice: Carefully observe the risk and machining note on Page 9! The upper side of the turned and clamped workpiece is now finished. The holes can be used in advance to determine the workpiece zero and the position (SINUMERIK measuring cycle "2 holes").	
The upper sides of the game pieces are then chamfered.	
The contours of the game pieces are now milled which means that the game pieces are released from the blank and are completely loose. They can be flung off by the cutting forces (danger from flying parts) and/or break out of the blank prematurely (resulting in a poor contour or workpiece edge). See dangers and machining instructions on Page 9: if no vacuum table and no preglued material is used, manually reduce the feedrate at the end of each contour using the override (if necessary down to 0%)!	
Remove the game pieces from the machine and if required, release from the temporary holding plate and clean.	
Completed game pieces	

7 Information in the Internet

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Construction of the parts, creation of the drawings, development of NC programs and the machining plans

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